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# Londoners' attitudes towards car-ownership and Mobility-as-a-Service: Impact assessment and opportunities that lie ahead

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# Executive Summary

The report "Londoners' attitudes towards car-ownership and Mobility as a Service: Impact assessment and opportunities that lie ahead" provides insights about Londoners' attitudes towards car-ownership, shared mobility services and Mobility as a Service (MaaS) as well as an impact assessment based on thought experiments about the potential introduction of MaaS in the city. The report has been prepared for Transport for London (TfL) by MaaSLab at UCL Energy Institute, University College London (UCL).

## Mobility in London and Challenges

London has changed substantially over the past two decades, both in terms of transport activity and in terms of economic and social characteristics. The period from 2000 onward saw significant improvements in public transport modes' capacity, quality, coverage and ticketing integration, and the congestion charge zone was introduced. New mobility services, such as vehicle sharing and ride-hailing schemes have also been initiated offering convenient alternatives to private car usage.

At the same time, TfL freely released its key data allowing for hundreds of new products and services to be developed that respond to Londoners' growing demand to access information about transport services via their smartphones. The effect of such efforts has been successfully reflected in a habitual change over the past decade, leading to an increasing number of Londoners willing to take up alternative transport services rather than sticking to their own cars.

However, London's traffic congestion is getting worse and the same is happening with air quality. Improvements in vehicle technology alone cannot solve the problem. More vehicles need to be taken out of the network if London wants to be a more enjoyable city to live in. London could lead a revolution in car use and car ownership over the next decade, by separating the two. Meanwhile, the public and private mobility services that operate in silos should be integrated to offer convenient alternatives to private car usage. New mobility concepts, such as Mobility as a Service, that are built on transport system integration, Internet of Things and sharing economy principles could contribute towards this vision.

## The Mobility as a Service Concept

The MaaS model covers several concepts that have been extensively discussed in the transportation sector during the last decades. These are the integration, interconnectivity and optimization of the transport services, smart and seamless mobility, and sustainability. The model also includes concepts that have recently emerged via the Internet of Things and the sharing economy, such as the term "as a service" and personalisation. MaaS envisages enabling a co-operative and interconnected single transport market and providing users with hassle free mobility. Via MaaS, travellers would be able to purchase mobility services that are provided by the same or different mobility operators by using just one platform and a single payment. Some hold an even more ambitious vision for MaaS, whereby MaaS users could cover the travel needs not only in their home-city, but anywhere around the world where MaaS schemes are available.

## Objectives and Survey Design

Although there are a lot of on-going discussions about MaaS, so far there is no quantified evidence about Londoners' preferences for sharing mobility and MaaS products, and the impact MaaS could have on mode choice behaviour and modal shift. Against this background the objectives of this report are to provide to the transport authority of the city insights into:

• citizens' attitudes towards owning and using a car in London;
• citizens' willingness to shift from vehicle ownership to vehicle usership;
• Londoners' attitudes towards MaaS and their preferences for different MaaS products;
• potential modal shifts in the MaaS era and the opportunities that could arise for the public transport system of the city;

• the impact of MaaS, as defined above, could have on the society, economy, environment and air-quality of London combining the findings from the surveys with a thought experiment; and
• areas where further research is needed.

The data used for the analysis in this report was collected through the London Mobility Survey (LMS), a survey designed by MaaSLab at UCL Energy Institute. LMS incorporates several parts of the London Travel Demand Survey, and has been enhanced with additional detailed questions about usage of new mobility services (i.e. car clubs, ride-hailing etc.), costs of car-ownership, 7-day smartphone-based tracking and stated preference experiments about MaaS.

## Attitudes towards owning and using a car in London

According to those survey respondents who own cars, owning and driving a car in Greater London does not necessarily make their life easier or more convenient. Many of them stated exactly the opposite as owning and using a car comes with a number of pain points that cost money and time.
• The average cost of the first vehicle ownership has been estimated to £233.5 per month (excluding maintenance and MOT costs) and 56% of car-owning participants stated that owning a car is a big expenditure for their household.
• The majority of car-owning participants claimed that driving in London is a nightmare. Congestion and finding a parking spot are the main contributing factors to this feeling. 55% of the car-owing participants stated that congestion is a huge problem when they drive, and 52% stated that it takes them a lot of time to find a parking space when they use their vehicles.
• One in four car-owning participants stated that they would like to have access to a car without owning one.
Many of the non-car-owners are not in favour of car ownership:
• 67% of them believe that there is no need to own a car in London, regardless of their age or the zone they live in. 59% of them also believe that owning a car is a big hassle.
• 18% stated that they would not buy a car in the future.

## Attitudes towards car sharing

Both car-owners and non-car-owners seem to be in favour of car sharing schemes and find it to be a good alternative to owning a car. Among the survey respondents, car sharing (through car clubs) is preferred over peer-to-peer car rental.
• Only 20% of car-owners stated that they are willing to rent their cars to others via a peer-to-peer car rental platform. However, some change their minds when they anticipate that they can have financial benefits from this.
• Younger car-owners (up to 39 years old) are more willing to share their cars via peer-to-peer car rental platforms.
• 45% of non-car owners stated that they would be happy to rent someone else's car. However, if they had a car, only 25% of them would be willing to rent out their car to someone else. It is easier for consumers to rent/use others' resources, instead of offering/sharing their own mobility resources.
• 39% of non-car-owning respondents see themselves participating in a car sharing (car club) scheme in the future with Millennials being the most eager to do so.
In general, the idea of car-ownership has been established for almost a century now, and car manufacturers have invested significant amounts of money to build the "dream" and status of owning a car. Car sharing schemes have only been around for a decade, yet Londoners seem to have accepted this new concept quite quickly and a significant percentage of them (more than one in three) are willing to use them in the future, instead of purchasing their own cars.

## Attitudes towards MaaS and car-ownership in the MaaS era

The virtual integration and bundling of sharing schemes and public transport modes in London together with being able to access of all these modes via a single interface, payment and ticketing method could further support the shift away from private vehicle dependence. Londoners seem to be willing to use MaaS,

as they believe that this service can offer them flexibility in their daily mobility, remove several of the travel related pain-points and in general, improve the quality of daily travelling. Certain factors have the potential to motivate people to subscribe to MaaS while others discourage them.

• 43% of respondents would be motivated to subscribe if MaaS gave them financial discounts. This percentage increases to over 55% for the most price sensitive age group of under 30 year olds.

• 52% of respondents would worry about running out of their subscribed amount, while 49% would feel trapped by subscribing to MaaS.

Regarding car-ownership in the MaaS era:

• MaaS could be used to introduce more people to public and shared transport modes. Half of the respondents agreed that they would try modes they previously did not use if their MaaS plan included them.

• MaaS has the potential to impact both car-owners' and non-car-owners' behaviour. 33% of car owners agree that MaaS would help them depend less on their cars, while a quarter of them would even be willing to sell their cars for unlimited access to car sharing for the next couple of years. Out of non-car-owning participants, 36% stated that they would delay purchasing a car and 40% stated that they would not purchase a car at all if MaaS were available.

Overall, even though there is still much to learn about MaaS, this study provides some promising insights to learn from. Discounts (that arise from bundling services) could motivate individuals, especially young people, to join MaaS and use public transport and active modes more. MaaS plans can help balance the modal split, by introducing people to modes they previously did not use. Finally, MaaS, if designed, structured and priced appropriately, could support the shift away from the private vehicle ownership by helping car owners depend less on their private vehicles and delay or diminish the need for non-car-owners to purchase these.

## Preferences for MaaS plans and their effect on mode choice behaviour

The results show that an effective MaaS system has to include public transport, with the vast majority of participants preferring plans which include such modes. Some mode combinations in MaaS plans are more popular than others and the modes included in the plans strongly influence the impact on mode usage.

• The most popular version of MaaS chosen includes public transport, car sharing and taxi with 26% of the respondents choosing this plan. Public transport was included in the top three most popular MaaS plans. As a result, these plans increase the usage of public transport the most compared to other travel modes.

Given the stated preference of including public transport in MaaS, it is important for authorities and operators to explore how public and private offerings could be integrated. When taxi services are split into traditional taxi and ride-hailing, users seem to prefer ride-hailing. The initiation of well-designed and priced MaaS products is expected to positively affect the use of public transport modes. It also has the potential to remove a significant number of vehicles from the network with drivers switching mainly to public transport. An increase in the usage of bike sharing is also expected, as it is a convenient mode especially for short distance trips.

## MaaS impact on mode switching

To assess the potential mode switching, the participants are split into two categories based on their current mode use profile: 1. Public transport users, and 2. Car users.

Out of those respondents who are currently regular public transport users:

• 28% stated that if MaaS were available, they would use more public transport,

• 23% said it would most likely have no impact on their public transport usage,

• 2% would most likely substitute part of their public transport usage with taxi,

• 14% stated that they would most likely use more bike sharing, showing that MaaS could help in increasing the use of active transport modes,

• 12% stated that MaaS would make them substitute part of their public transport use with car sharing.

Out of those who are regular car users:
• 35% stated that they would substitute car usage for public transport (bus, tube, rail),
• 13% stated that their car usage would not be affected by MaaS,
• 17% would substitute their car trips with bicycle, and a further 17% would walk more as part of their trips,
• 11% would travel by taxi (including ride-hailing) instead of private car if MaaS were available.

## Wider impact assessment of MaaS

We have applied a thought experiment approach to speculate what participants' attitudes might mean in terms of wider impacts to London's transport system. While this is not based on detailed analytical, operational and commercial modelling of the transport network, it provides some indications as to the ways that a MaaS system, if structured and priced appropriately, could impact the city. Further research, through testing and transport modelling, is needed to provide quantifiable evidence. The details of how any MaaS implementation is structured plays a key role in determining the impacts MaaS would have and the degree to which these could be positive. If structured and priced properly, MaaS could have benefits such as increased use of public transport, active transport and intermodal solutions, to mobility challenges; it could also improve network efficiency through optimising supply and demand, especially in peak hours where certain modes/routes are under-utilised. A well-structured and priced MaaS could also have positive impacts on the environment and open up new business opportunities to foster modal integration, while helping Londoners improve their travel experience.

When the era of connected and autonomated vehicle comes, MaaS systems and autonomous vehicles will exist in symbiosis. MaaS users will only need one account to access the autonomous vehicle services supplied by different public transport and shared mobility providers. MaaS, could prepare the transport ecosystem for a smooth transition to autonomous vehicles.

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# 1. Introduction

London has changed substantially over the past two decades, both in terms of transport activity and in terms of economic and social characteristics[1]. The period from 2000 onward saw significant improvements in public transport modes' capacity, quality, coverage and ticketing integration, and the congestion charge zone was introduced. New mobility services, such as vehicle sharing (car clubs, ride sharing/carpooling, bike sharing) and ride-hailing schemes have also been initiated offering convenient alternatives to private car usage. At the same time, TfL freely released its key data allowing for hundreds of new products and services to be developed that respond to Londoners' growing demand to access information about transport services via their smartphones. The effect of such efforts has been successfully reflected in a habitual change over the past decade, leading to an increasing number of Londoners willing to take up alternative transport services rather than sticking to their own cars. However, London's traffic congestion is getting worse and the same is happening with air quality[2]. Improvements in vehicle technology alone cannot solve the problem. More vehicles should be taken out of the network if London wants to be a more enjoyable city to live in. New mobility concepts, such as Mobility as a Service (MaaS), that are built on transport system integration, the Internet of Things and sharing economy principles could contribute towards this vision.

## 1.1 Car-ownership in Great Britain and London

Understanding the current situation and trends in car-ownership is an important first step to achieving modal shift away from private vehicles and accelerating the penetration of new mobility services. London historically has had low levels of car ownership compared to the rest of the United Kingdom (UK). Whilst the per capita number of licensed cars in the UK has been increasing gradually over the last 20 years, London's figures remained fairly unchanged (slightly above 0.3 cars per person) until the global financial crisis in 2008, where the numbers started to slightly decline (Figure 1.1.1). As for the total number of licensed cars, the annual increase in London has also been slower compared to the increase in the rest of the UK[3].

Fig. 1.1.1: Number of licensed cars per capita
(source: Vehicle licensing statistics 1994-2015, DfT)
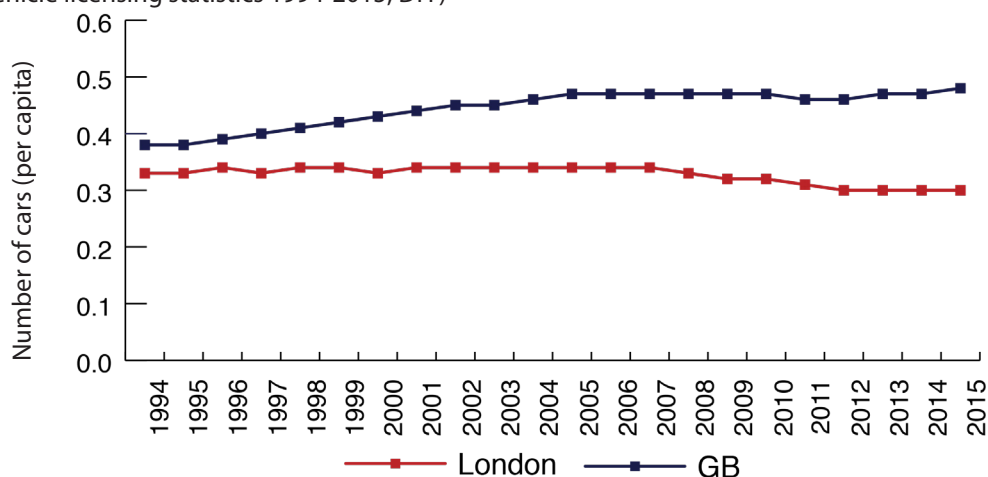


In terms of household car ownership, the statistics show that the proportion of London households owning "No car", "One car" and "Two or more cars" remained stable between 2005 and 2014[4] (Figure 1.1.2). More insights can be gained by breaking down the results into different household groups based on their socio-demographic characteristics. In 2014, the percentage of London households that owned at least one car

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[1] Clowes, J., 2015. Rising population, falling traffic: why has car ownership fallen while London has prospered? Paper presented at European Transport Conference 2015.

[2] Cookson, G, 2017. Congestion is growing: so how do we tackle it? Available at: http://inrix.com/blog/2017/02/congestion-is-growing-so-how-do-we-tackle-it/

[3] Department for Transport., 2016. Vehicle licensing statistics. Available at: https://www.gov.uk/government/collections/vehicles-statistics

[4] Transport for London., 2016. London Travel Demand Survey.

increased with household size until stabilising at around 80% for households with 4 or more members (Figure 1.1.3). However, the most noticeable result came from single-member households where only 33% had access to a car; a rate significantly lower than the other groups. A similar trend can also be seen with regards to household income. Only 25% of the poorest households (yearly income below £10,000) had at least one car whereas the other income groups all had an ownership rate above 50%.

Fig. 1.1.2: Number of cars owned by London households (source: London Travel Demand Survey 2005-2014, TfL)
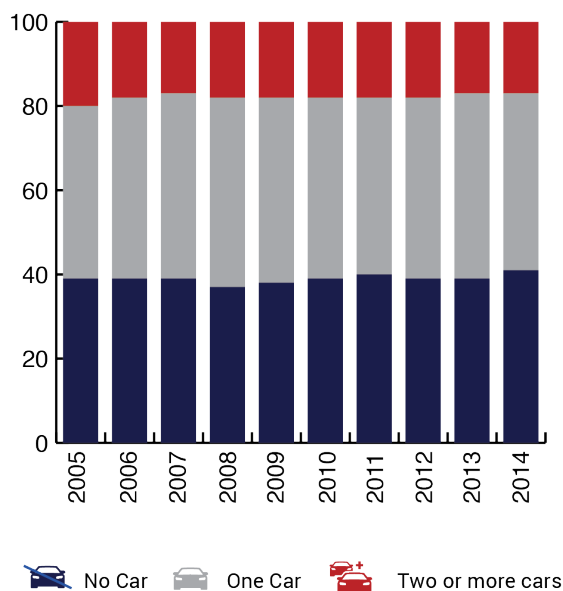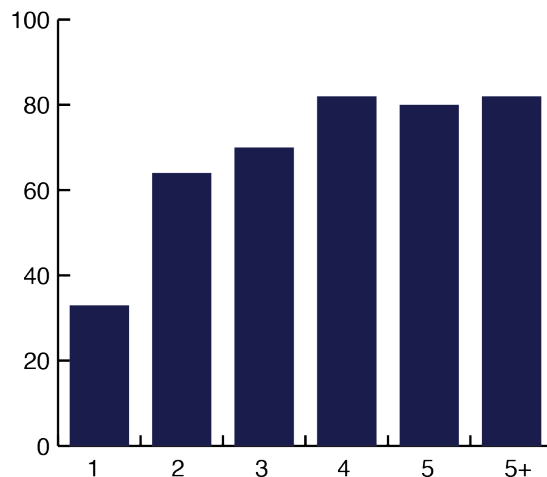
Fig. 1.1.3: Percentage of households owning at least one car by household size (source: London Travel Demand Survey 2014, TfL)



No Car    One Car    Two or more cars

Looking at individual characteristics, in 2014, 48% of the adult males in London were users of at least one car; for female adults, the ratio was 37%. In terms of age, 45-59 year olds are the main users of their household vehicles. With regards to employment status, around 60% of self-employed people (including both full-time and part-time) had frequent access to a car, which was the highest among all employment categories.

From the statistics above, it can easily be seen that Londoners do not have a strong dependence on their cars in the current era, especially among certain socio-demographic groups, such as Millennials. This has made London into an incubator for new, alternative mobility services, which Londoners have shown great enthusiasm for.

## 1.2 New mobility services in London

London is one of the few cities in the world that offers a variety of new mobility services, such as car clubs, peer-to-peer car rental, ride-hailing, bike sharing and ride sharing schemes (Figure 1.2.1).
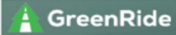
Being either a "Back-to-base" or a "One-way" service, many car club companies have emerged in recent years. The latest figures show that from 2015 to 2016, the number of car club members in London has risen from 155,000 to 186,000 while round-trip members per car have also increased from 66 to 70 people[5]. Meanwhile, the various ride sharing service providers have effectively supported the city of London in surpassing its goal for 2024 (9.3% carpooling rate) way ahead of time[6] (by 2009, the rate had increased to 10.5%). As for the taxi market, a number of ride-hailing services (peer-to-peer (P2P) taxi) have come to play.

[5] Carplus., 2016. Carplus auunal survey of car clubs, 2015-2016 London. Available at: https://www.carplus.org.uk/wp-content/uploads/2015/03/Carplus-Annual-Survey-of-Car-Clubs-2015-16-London_Final-2.pdf

[6] Stanford, J., 2015. Update: regional rideshare program. Report to the April 20th 2015 Civic Works Committee Meeting. Available at: https://www.london.ca/newsroom/Documents/RideShare.pdf

Unlike the traditional black cab and mini cab operators[7], these new services do not own any taxi fleets. Instead, they gather information from partner operators and serve as booking platforms for passengers. The revolutionary P2P model has also changed car rental industry. Nowadays, besides the traditional car rental companies, individual car owners can also easily rent out their cars via the P2P car rental platforms. This new market has kept growing given the large demand from users, i.e. more than 20% of the UK adults rented a car in 2015[8]. Finally, there has also been a continuous increase in the number of Santander Cycle hires from the 2,180,813 in 2010 to 10,303,637 in 2016[9]. Dockless bike sharing schemes have also been initiated recently.

Fig. 1.2.1: New mobility services available in London



London could lead a revolution in car use and car ownership over the next decade, by separating the two. It may soon be unnecessary to own a car to enjoy the full benefits of car ownership, due to a combination of continued improvements in public transport, the surge in app-based car hire services, and the growth of car club schemes. However, all these services usually operate in silo and are not integrated with each other. The virtual integration of the available modes in London, is a missing piece of the puzzle that could accelerate the reduction of the number of the vehicles in London's network.

## 1.3 The Mobility as a Service concept

The MaaS concept covers several concepts that have been extensively discussed in the transportation sector during the last few decades[10]. These are the integration, interconnectivity and optimization of transport services, smart and seamless mobility, and sustainability[11]. The MaaS concept also includes concepts that have recently emerged via the Internet of Things and the sharing economy, such as the term "as a service" and personalisation. Although there are already mobility services that cover these terms (i.e. car sharing, on-demand transport), they usually operate in silo and are not integrated with other modes - especially with public transport. MaaS envisages enabling a co-operative and interconnected single transport market and providing users with hassle free mobility.

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[7] Partner operators can be cab companies or independent drivers.

[8] British Vehicle Rental and Leasing Association., 2016. Renting, the big picture. Available at: http://www.bvrla.co.uk/research/article/renting-big-picture

[9] Transport for London., 2017. Number of bicycle hires. Aavailable at: https://files.datapress.com/london/dataset/number-bicycle-hires/2017-04-06T08:41:52.69/tfl-daily-cycle-hires.xls

[10] Kamargianni, M., and M. Matyas 2017. The Business Ecosystem of Mobility as a Service. 96th Transportation Research Board (TRB) Annual Meeting, Washington DC, 8-12 January 2017.

[11] Venable, J. R., Pries-Heje, J., Bunker, D., & Russo, N. L. 2010. Creation, Transfer, and Diffusion of Innovation in Organizations and Society: Information Systems Design Science Research for Human Benefit. In J. Pries-Heje, J. Venable, D. Bunker, N. L. Russo, & J. I. DeGross (Eds.), Human Benefit through the Diffusion of Information Systems Design Science Research: 1–10. Berlin: Springer.

Currently, Londoners and in general travellers, have to use numerous tools in order to find information and purchase and access different transport modes. Travellers usually use different journey planning tools to plan their trips. However, most of the existing journey planners do not offer information for intermodal trips (that is, do not combine more than one transport mode – with the exception of walking that is usually the access and egress mode), and only include some of the available transport modes in an area. Furthermore, travellers have to use different payment methods for each transport mode; for example, some transport operators only accept cash, others accept cards, smartphone payment or PayPal. Once again, travellers need different tickets/ways to access each mode (public transport modes in London, except Santander bikes, are already accessed using the same ticket/smartcard, but there is no ticket integration with other transport modes; contactless payment has also been introduced to public transport modes in London leading the way to easier payment integration). These are only some of the pain points that deteriorate mobility and hinder intermodality (refers to the use of two or more transport modes in a trip[12]) or multimodality (refers to the use of different modes for different trips) and the choice of sustainable travel behaviours.

The MaaS concept removes many of these user-related pain points. Via one version of MaaS, travellers would be able to purchase mobility services that are provided by the same or different mobility operators by using just one platform and a single payment (Figure 1.3.1). The MaaS services, depending on their business model, usually provide a dynamic multiservice journey planner (offering combinations of the different transport modes available for an area, such as car club, car rental, underground, rail, bus, bike sharing, taxi), a booking system, a single payment method (single payment for all transport modes), and real time information[13]. MaaS users can use the service either as Pay-As-You-Go or purchase mobility packages based on their or their households' needs.

One model of operation is to have one or more MaaS providers who act as the intermediary between transport operators and users (the decision of the identity of the MaaS operator is not in the scope of this report (for an in-depth discussion on this, see Kamargianni and Matyas 2017[10]). In this case, the MaaS provider uses the data that each transport operator offers (via secure Application Programming Interfaces APIs), and resells tickets or capacity (i.e. km) to users. The users use just one interface to find information and choose the preferred transport mode for their trips. The principle would be that the MaaS operator can propose the ideal combination of transport modes to them for each trip by knowing the network conditions in real time (supply side) and the preferences of users (demand side). In other words, the MaaS provider can optimise the supply and the demand.

Some also envisage that MaaS could not only bridge the gap between transport operators in the same city, but also across different cities, which may initiate the idea of roaming in the transport sector. Nowadays, it is common for someone to live outside Greater London (usually due to better quality of life or properties prices) and commute to London. At the same time long-distance business trips have been increased, as London is one of the biggest business centres in the world. MaaS providers could cover the travel needs of their customers not only in their home-city, but anywhere around the world where they operate. This is already a feature that some of the on-demand and car sharing services offer. For example, a user can use/access ride-hailing services in all the cities where the companies operate by using the same app and by having the same user account and payment details. Figure 1.3.1 depicts the current situation for urban and intercity trips from a user's point of view and the way transport services could be accessed when MaaS services are available.

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[12] Berwick, D. M. 2003. Disseminating Innovations in Health Care. JAMA, 289(15):1969–1975.

[13] Kamargianni, M., Matyas, M., Li, W., Schäfer, A., 2015. Feasibility Study for Mobility as a Service Concept for London. UCL Energy Institute report, Prepared for the UK Department for Transport.

Fig. 1.3.1: Without and with MaaS from a traveller's point of view
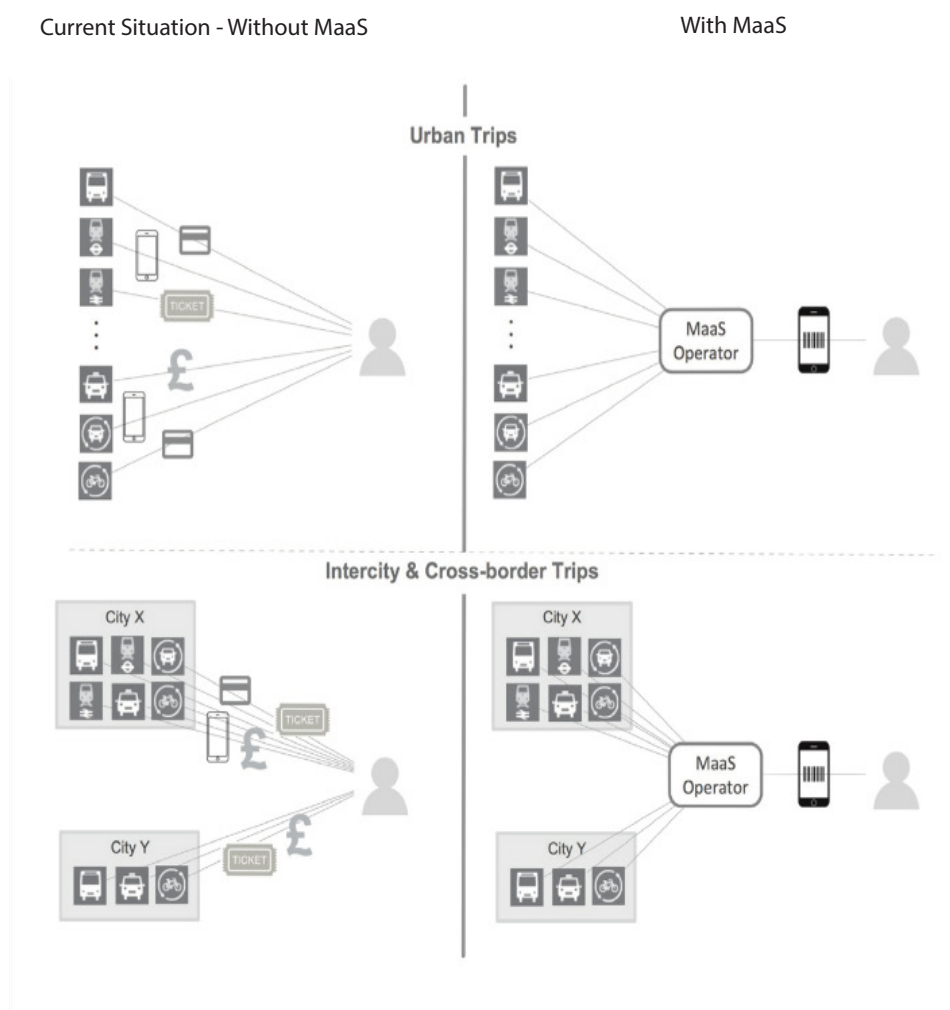
## 1.4 Objectives of the report

MaaS may lead to significant changes in Londoners' car ownership and mode choice behaviour as users will be offered an opportunity to enjoy door-to-door seamless mobility without the need to own a car. As a result, wider benefits such as less congestion and better air quality may also be seen. Although there are a lot of ongoing discussions about MaaS, so far there is no quantified evidence about Londoners' preferences for sharing mobility and MaaS products, and the impact MaaS could have on mode choice behaviour and modal shift. Against this background the objectives of this report are to provide to the transport authority of the city insights about:

• citizens' attitudes towards owning and using a car in London;
• citizens' willingness to shift from vehicle ownership to vehicle usership;
• Londoners' attitudes towards Mobility as a Service and their preferences for different MaaS products;
• potential modal shifts in the MaaS era and the opportunities that could arise for the public transport system of the city;
• the potential impact MaaS, as defined in this report, could have on the society, economy, environment and air-quality of the city based on a thought experiment applied to the findings from the conducted survey; and
• topics that need further research.

## 1.5 Survey and Sample

Since there is no existing dataset about Londoners' travel behaviour, choices, attitudes and perceptions about new mobility services, and preferences towards MaaS, a survey has been designed specifically to collect information about the aforementioned topics. The survey is called London Mobility Survey (LMS)[14] and it has been designed by the MaaSLab[15] at University College London (UCL). There are two versions for the LMS survey: 1. the on-line LMS, and 2. the smartphone based LMS. Both survey tools collect the same data, but smartphone-LMS is enhanced with a tracking app, the Future Mobility Sensing[16] (FMS). LMS incorporates several parts of the London Travel Demand Survey to allow for comparisons, while it has been enhanced with additional detailed questions about usage of new mobility services (i.e. car clubs, ride-hailing etc.), and costs of car-ownership. LMS consists of 3 steps:

1. The pre-questionnaire, where participants are asked about their socio-demographic and mobility tool ownership characteristics along with their attitudes towards private vehicle ownership and sharing mobility. This step is available in both LMS versions and provides the data used for analysis in Chapters 2, 3, 4, 5, and 6 of this report.

2. The tracking app; after the completion of Step 1, participants of the smartphone based LMS are asked to download the app on their smartphones and track their activities for 7 days. During the tracking participants are required to log back in the LMS webpage and validate their activities and answer some additional questions. Data from this step is not used in the analysis presented in this report.

3. The exit section; for the smartphone based LMS, when the 7-day tracking and validation is complete, respondents are shown with their Mobility Record (an aggregated summary of the number of trips, duration, travel time and cost broken down by each transport mode). Based on their Mobility Record hypothetical MaaS monthly packages (stated preference experiments) are generated including several combinations and amounts of the available transport modes in London[17]. Participants are asked to choose the MaaS monthly plan that better fit to their needs. For each MaaS package the participants choose, they are asked to indicate potential changes in mode use and potential mode shifts. Finally, a number of questions with regards to attitudes towards MaaS products are asked. For the on-line LMS, the participants are presented with this part, right after step 1. Data from this step has been used for the analyses in Chapters 4, 5, and 6.

For the purpose of this report, the sample used consists of 1570 individuals. The smartphone based LMS sample consists of 343 individuals who were randomly selected via the Work.Shop.Play panel of Exterion Media. For the on-line LMS, a panel of 1,227 individuals was hired; the socio-demographic characteristics of this sample are representative of London population based on gender, age, residential zone and driving license possession. This merged sample consists of individuals who live in Greater London[18]. Only people with access to web and those over 18 were eligible for the study[19]. The data used in this report was collected between November 2016 and February 2017 (excluding the holidays). For details about the sample characteristics please see Appendix A.

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[14] https://london.fmsensing.com/general

[15] https://www.maaslab.org

[16] https://its.mit.edu/future-mobility-sensing

[17] Matyas, M. and Kamargianni, M., 2017. Stated preference design for exploring demand for "Mobility as a Service" plans. Paper presented at the 5th International Choice Modelling Conference, Cape Town, South Africa, 3-5 April, 2017.

[18] For readers' ease, when we refer to London in this report, we mean Greater London (within M25 area).

[19] Four out of five adults in the UK have a smartphone. Among 18-44 year olds, smartphone adoption is higher than 91% (Deloitte, 2016. Global Consumer Survey: UK Cut. Available at: https://www.deloitte.co.uk/mobileuk/ )

## 1.6 Structure of the report

The rest of the report is structured as follows:

• Section 2 elaborates on attitudes towards owning and driving a car in London;
• Section 3 presents Londoners' attitudes and willingness to use sharing mobility services;
• Section 4 offers insights about Londoners' attitudes and preferences towards Mobility as a Service;
• Section 5 presents the first quantified evidence about MaaS products and their effect on mode choice behaviour; and
• Section 6 provides insights about potential modal shifts in case MaaS is available in London, and speculates on the consequences these could have on the public transport system, society, the environment, the economy, and the air-quality of the city.

# 2. Londoners' attitudes towards owning and using a car

London, which has pioneered congestion charging and has a well-integrated public transport system, has led the move away from cars over the past decade, with a significant number of car commuters have switched to other forms of transport[20]. However, the number of private vehicles on the transport network still remains a huge problem for the city. Understanding how drivers feel and the pain points they face while driving is an important first step for designing services that can move them away from owning or using a private car. This section focuses on analyzing and comparing car-owners and non-car-owners' attitudes towards owning and using a car in London. The cost of owning a vehicle in London is also calculated taking into account parking and congestion charging expenses that are usually excluded from the car-ownership cost. 75% of the participants in the survey have a driving license, while 66% of the participant households own at least one vehicle.

## 2.1 Car-owners' attitudes towards driving in London

According to many of the survey respondents, owning and driving a car in Greater London does not make their life easier. 74% of car-owning participants agreed to the statement "Driving in London is a nightmare" (Figure 2.1.1).

Recent findings indicate that London is the most congested European city, with the capital's drivers spending an average of 96 hours stuck in traffic in 2016[21]. This is reflected in this survey as well, with 55% of the car-owners stating that congestion is a problem when they drive (Figure 2.1.1).

Another pain point of owning and driving a car in London is finding a parking space. 52% of the car-owning participants declared that it takes them a lot of time to find a parking space when they use their vehicles (Figure 2.1.1).

Fig. 2.1.1: Attitudes towards driving in London



"Driving in London is a nightmare"

13% 14% 74%
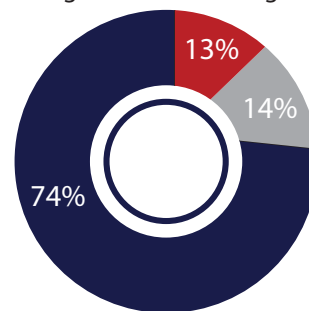
"It takes me a lot of time to find a parking space when I use my car"

24% 21% 55%
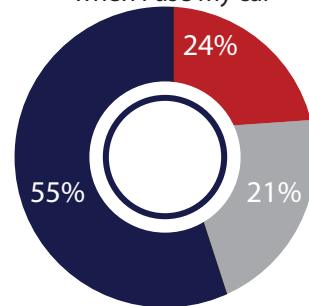
"Congestion is a problem when I drive"

24% 23% 52%

● Disagree   ● Neutral   ● Agree

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[20] http://content.tfl.gov.uk/travel-in-london-report-8.pdf
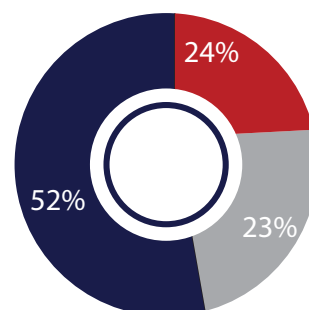
[21] INRIX., 2016. INRIX reveals congestion at the UK's worst traffic hotspots to cost drivers £62 billion over the next decade. Available at: http://inrix.com/press-releases/inrix-reveals-congestion-at-the-uks-worst-traffic-hotspots-to-cost-drivers-62-billion-over-the-next-decade/

## 2.2 Car-owners' attitudes towards owning a car in London

Apart from the capital cost needed to purchase it, owning a car also entails a number of other expenses, such as road tax (VED), insurance, fuel, parking, MOT and other maintenance costs. To add to this, car-owners in London have some other costs, for example congestion charging and higher car-insurance contracts as the risks of a collision or a car crime (such as theft of- or from a vehicle, uninsured driving or attempts at 'cash for crash' fraud) is much higher[22] than in other areas.

Tracking all the aforementioned costs to calculate the exact cost of car-ownership is quite difficult for the owners, as each service is usually paid at different points in time. For the purposes of this study, the average cost of ownership for the first vehicle in each household in our sample is £233.5 per month. For the calculation of this, the costs presented in Table 1 were taken into account, while the maintenance and MOT costs were excluded because these costs depend on the age of the car and vary across the years; by adding these costs, the cost of ownership is expected to be higher.

Table 1: Cost of car-ownership for the first vehicle of the household

| Cost | Per Month | Per Year |
|---|---|---|
| Average fuel cost | £70.5 | £846 |
| Average VED (road tax): | £11.8 | £142.6 |
| Average insurance cost | £75.8 | £909.6 |
| Average cost of resident parking permit for first vehicle | £8.1 | £97.8 |
| Additional parking costs for the first vehicle | £29.8 | £357.6 |
| Average cost of entering Congestion Charging Zone | £37.5 | £450 |
| | **£233.5** | **£2,802** |

Regarding their attitudes towards costs of car-ownership, 56% of respondents believe that owning a car is a big expenditure for their household (Figure 2.2.1).

Studies have shown, that some car-owners tend to personify their cars to the point that the relationship with them mirrors relationships with living beings in their lives[23]. In addition to the large financial investment, a car can become a significant emotional investment – it is there with them for major milestones in their lives like weddings, babies and graduations and it is literally the 'vehicle' that makes them being physically present in these moments possible. 51% of the participants stated that they are attached to their car, while 30% completely disagree with this statement (Figure 2.2.1). The majority of those who feel attached to their car belong to older age groups (over 40 years old), while most of the Millennials do not share this sentiment.

Many car-owning participants do not like the idea of just having access to a car without owning it (Figure 2.2.1). 48% of them disagree with the statement "I would love to have access to a car without the hassle of owning one". However, 32% agree with this statement, which means there is potential even among current car owners for a shift from ownership to usership (i.e. car sharing).

Fig. 2.2.1: Car-owners' attitudes towards owning a car



"Owning a car is a big expenditure for my household"
21%
23%
56%

"I am attached to my car"
30%
19%
51%

"I would love to have access to a car without the hassle of owning one"
32%
48%
20%

● Disagree ● Neutral ● Agree

---
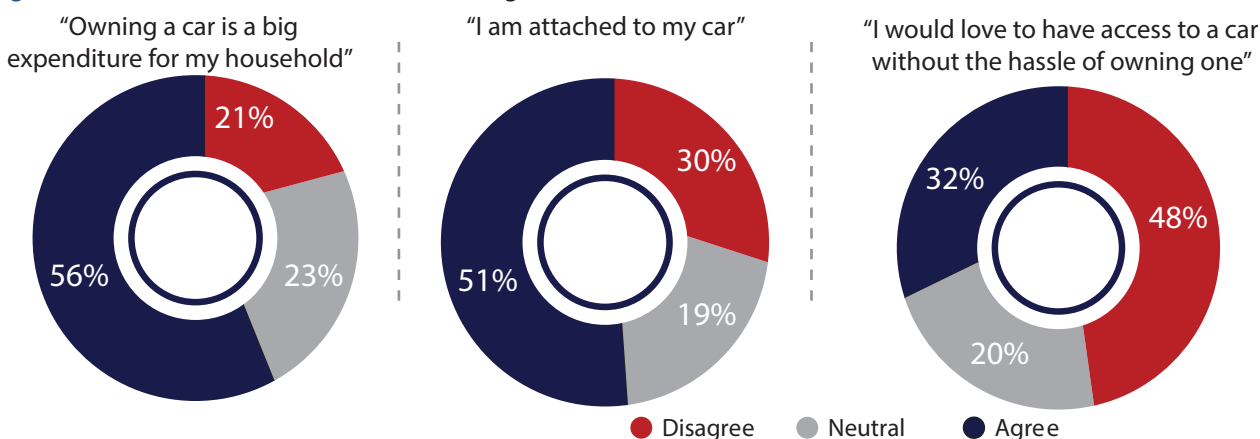
[22] Confused., 2016. Car insurance price index. Available at: https://azcdubmedia.azureedge.net/media/themes/fab-four/Price-index/layout/2016Q4/Confused-com-car-insurance-price-index-Q4-2016.pdf

[23] Carriere, N., 2013. Survey reveals relationships with cars mimic relationships with people. Available at: http://press.autotrader.com/2013-06-04-Survey-Reveals-Relationships-with-Cars-Mimic-Relationships-with-People

## 2.3 Non-car-owners' attitudes towards owning a vehicle in London

London is a city with many characteristics that could enable a car-free lifestyle. It has a very good public transport system with extensive coverage as well as several other options, such as car sharing, bike sharing and ride-hailing services. 34% of the participants in this survey do not own a vehicle and in most cases this is a conscious choice.

The majority (67%) of non-car-owning survey respondents believe that there is no need to own a car in London regardless of their age (Figure 2.3.1). The public transport system of the capital satisfies their travel needs and they usually use active transport or ride-hailing services when public transport is not an option.

71% of non-car-owners believe that the number of cars is a big problem for London (Figure 2.3.1). 78% of respondents over 50 years old, in comparison to only 63% of those between 30 to 39 years old, agree with this statement. Although private car-ownership has decreased in recent years, the roads of the capital are still congested.

**Fig. 2.3.1:** Non-car-owners' attitudes towards owning a car in London

"I believe there is no need to own a car in London"
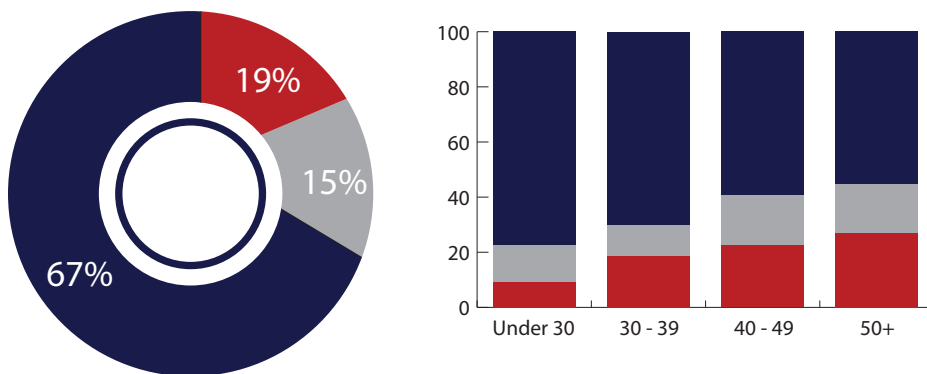


"The number of cars is a big problem in London"
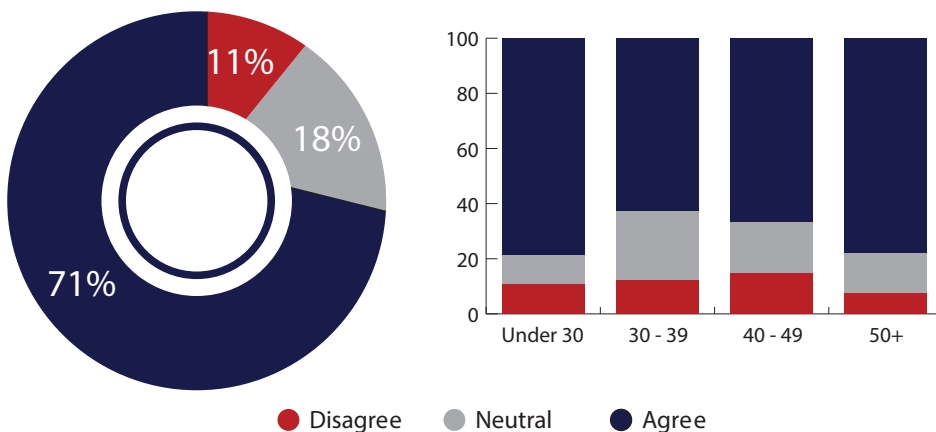


● Disagree   ● Neutral   ● Agree

Most of the non-car-owning participants believe that owning a car is a big hassle (59%). Respondents under 29 years old agree most with this statement (Figure 2.3.2). This attitude remains fairly consistent across residential areas, genders and ethnicity.

56% of the non-car-owners agree that a car is just a means to go from A to B and there is no need to own one (Figure 2.3.2). Those between 40-49 years old seem to agree more with this statement.

Nowadays the number of services that offer people the opportunity to use a car without owning it is constantly increasing. London offers a variety of such services with 36% of the participants agreeing that

there is no need to own a car in the "as a service" era we live in (Figure 2.3.2). Given that it takes years and in some occasions, generations for behaviour to change, this is a very interesting finding indicating a potential trend towards reducing car ownership levels in the future. When analyzing the scores for each age group, those who disagree the most with this statement are participants between 40-49 years old (43%)

Fig. 2.3.2: Non-car-owners' attitudes towards owning a car

"I just want to go from A to B; there is no need to own a car"
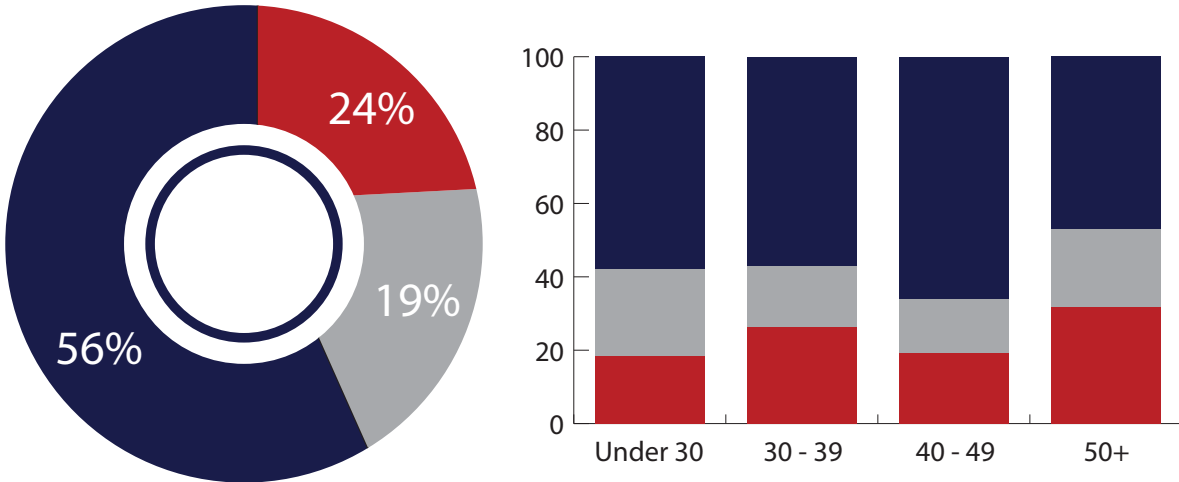


"Owning a car is a big hassle"
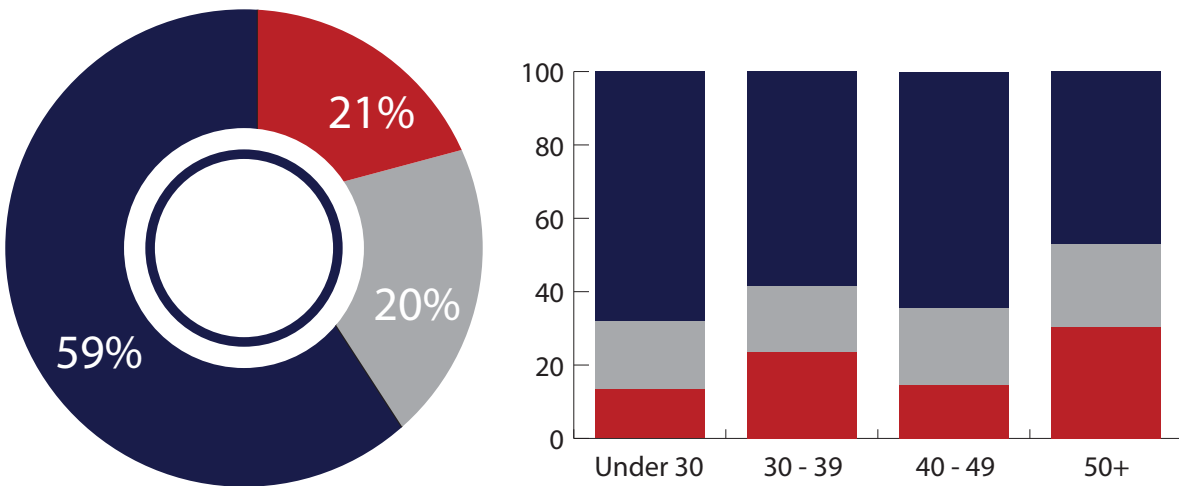


"There is no need to own a car in the "as a service" era we live"
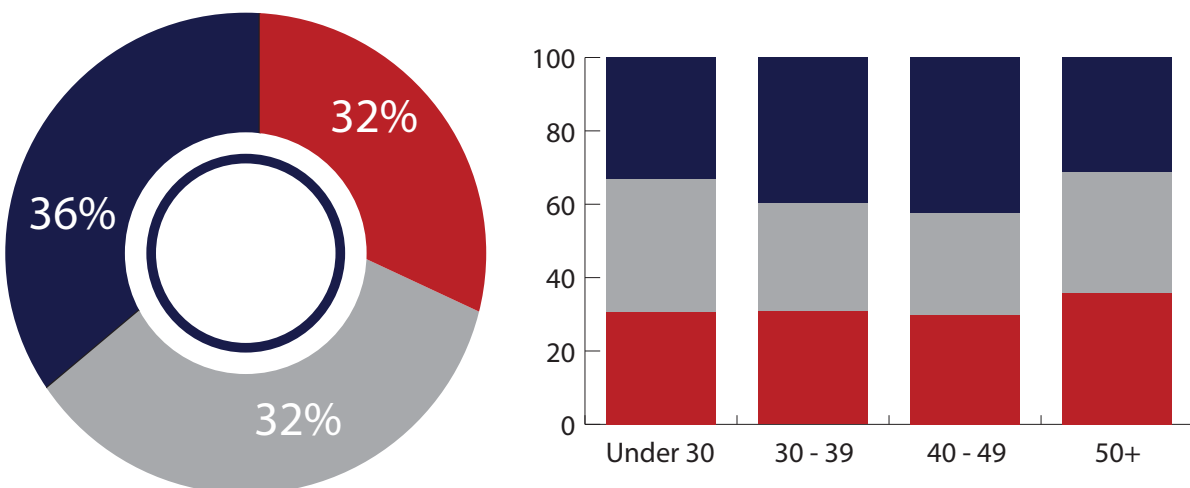


● Disagree　● Neutral　● Agree

In general, 47% of non-car-owning participants believe that people should buy fewer cars. By comparing the answers of each age group, it can be seen those between 40-49 agree most with this statement, followed by those between 30-39 years old; those over 50 agree the least (Figure 2.3.3).

When the current non-car-owners where asked about their future plans regarding purchasing a vehicle, 57% of them agreed and 18% disagreed with the statement "I will definitely buy a car in the future" (Figure 2.3.3). The younger participants agree most with this statement; 59% of those under 29 and 52% of those between 30 and 39 declare that they will purchase a car in the future. This answer may be partially motivated by this generation thinking about having children, settling down or moving to suburban areas outside London in the future. However, it can be seen, that as the age increases a higher proportion of participants agree with the fact that they will not purchase a vehicle.

Fig. 2.3.3: Non-car-owners' attitudes towards purchasing a car



"I think people should buy fewer cars"

"I will definitely buy a car in the future"

Disagree   Neutral   Agree
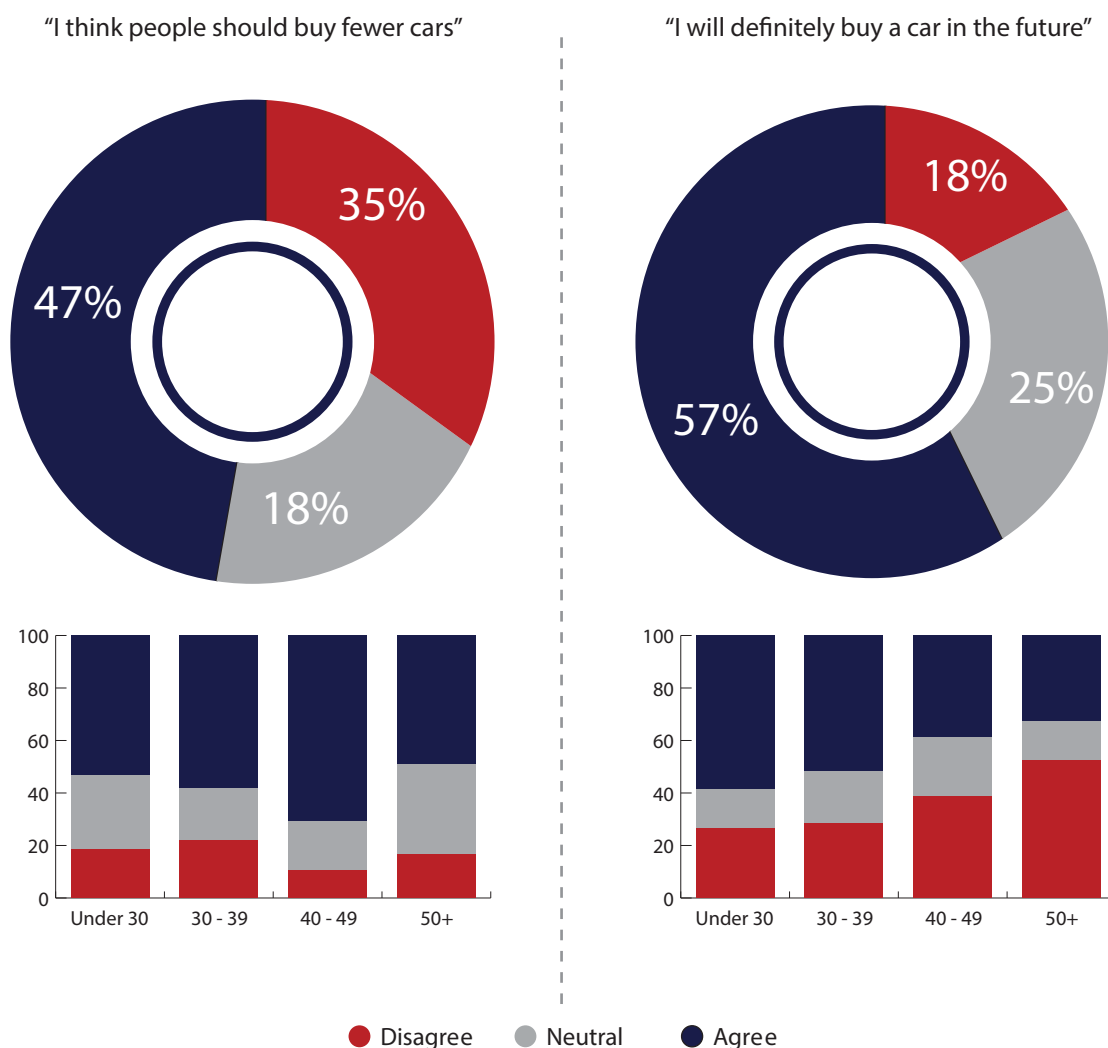
# Highlights

› The average cost of ownership for the first vehicle is £233.5 per month / £2,802 per year (excluding maintenance and MOT costs).

› 56% of car-ownning participants believe that owning a car is a big expenditure for their household.

› 32% of car-owners are in favour of just having access to a car without the hassle of owning one.

› Car-owners seem to face several pain points while driving:

- 74% of the car-owning participants claimed that driving in London is a nightmare.

- 55% of car-owners stated that congestion is a problem when they drive.

- 40% of the car-owning participants declared that it takes them a lot of time to find a parking space when they use their vehicles.

The survey results suggest, that the vast majority (67%) of non-car-owners believe that there is no need to own a car in London, regardless of their age or the zone they live in.

- 71% of non-car-owners also believe that the number of cars is a big problem for the UK capital.

- 59% of non-car-owning respondents believe that owning a car is a big hassle.

- 47% of the non-car-owning participants believe that people should buy fewer cars.

- 18% of non-car-owners stated that they will definitely not buy a car in the future. Millenials are those who agree the most with this statement.

- In general, owning a vehicle in London is a substantial expense for households. Instead of making their lives easier, the majority of respondents believe it adds an additional challenge to their daily life as they lose time stuck in traffic or trying to find a parking space. That's why the great majority of participants stated that driving in London is a nightmare and 32% of them would like to have access to a car without owning one..

# 3. Londoners' attitudes towards sharing mobility

In the coming years, London faces challenges of population growth and increased congestion which will threaten air quality and the environment. Shared mobility provides a cost-effective and flexible alternative to owning a car, and can help tackle these challenges. Joining a shared mobility scheme provides the convenience of owning a car without the hassle and costs of repairs, servicing or parking. Members can book cars locally for just an hour, up to a whole weekend, or longer. But how open are Londoners to these sharing mobility concepts? This section focuses on Londoners' attitudes towards car sharing schemes and peer-to-peer rental.

## 3.1 Comparing car-owners and non-car-owners' attitudes towards shared mobility

Car sharing schemes have started expanding in the UK capital, with more than 10 schemes currently available in London. 80% of the participants in this survey are aware of the car sharing (car clubs) concept[24], while 10% of the participants are members of such a scheme.

In general, both car-owners and non-car-owners seem to be in favour of car sharing (Figure 3.1.1). The majority of both car-owning (51%) and non-car-owning (63%) participants agree that car sharing is a great way to have access to cars without owning one. 55% of non-car-owners compared to 72% of car-owners agree with the statement that "Overall, sharing cars makes sense". A big difference can be seen regarding the statement "Car sharing is a better way of using cars than everyone buying their own", with 65% of non-car-owners agreeing with this, while only 47% of car owners share this view. However, the percentage for car-owners is still quite high, indicating that almost half of the car-owners anticipate that sharing is better than owning.

**Fig. 3.1.1:** Car-owners and non-car-owners' attitudes towards car sharing schemes
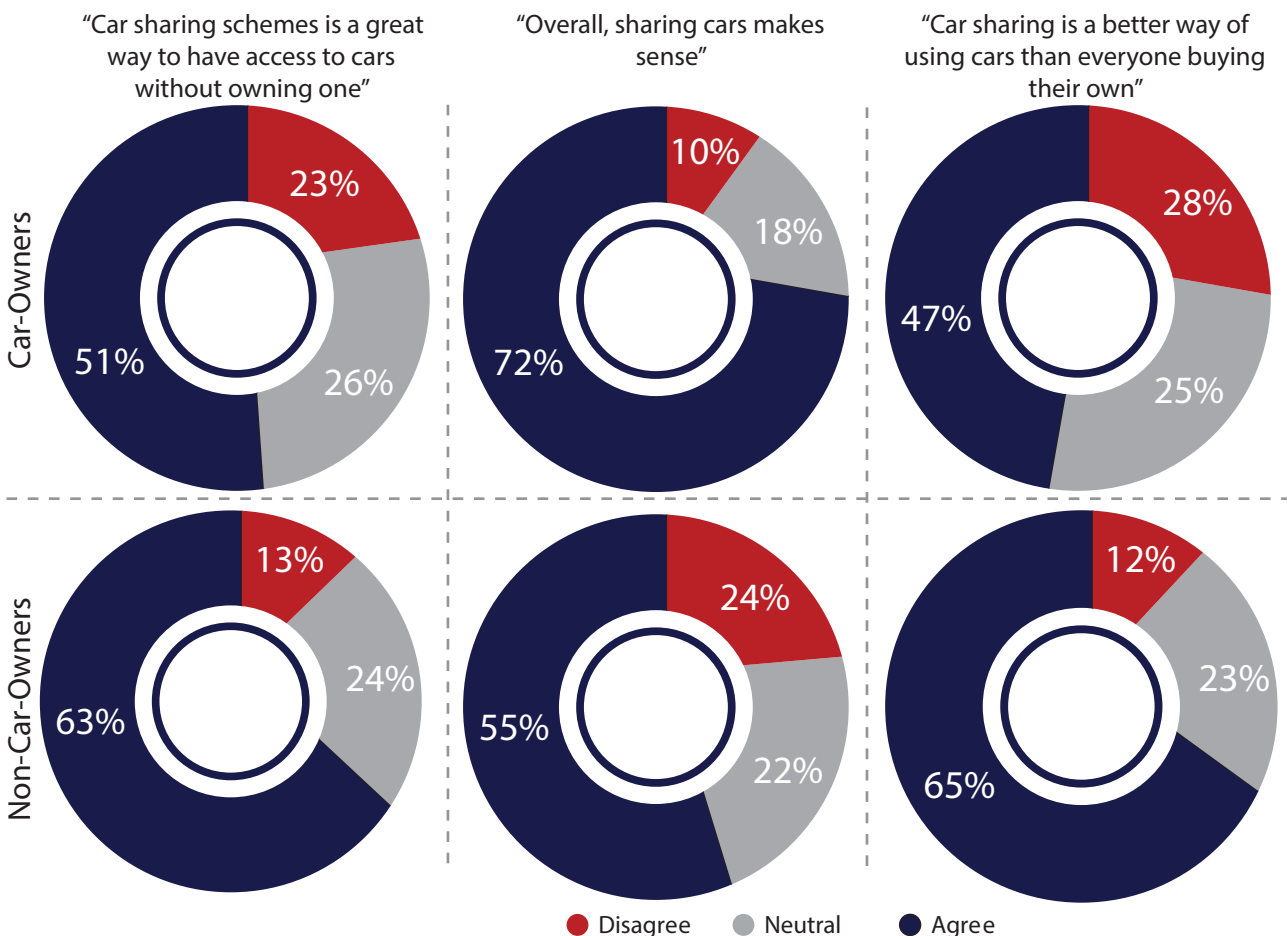


[24] To avoid any misunderstanding, the car sharing (car club) concept was defined before asking the survey participants if they are aware of the availability of such a concept in their city.

## 3.2 Car-owners attitudes towards sharing mobility resources

Focusing now only on car-owners, we explore their attitudes towards shared mobility and their willingness to shift from consumers to "prosumers", in other words, to provide/rent their vehicles to others via peer-to-peer car rental platforms.

28% of car-owning participants agree that more people should rent their cars to others when they are not using them (Figure 3.2.1). The differences across age groups are not that significant, but the under 29 age group has the highest number of respondents in favour of this statement.

Fig. 3.2.1: Car-owners' attitudes towards sharing cars

"More people should rent their cars to other people when they are not using it"
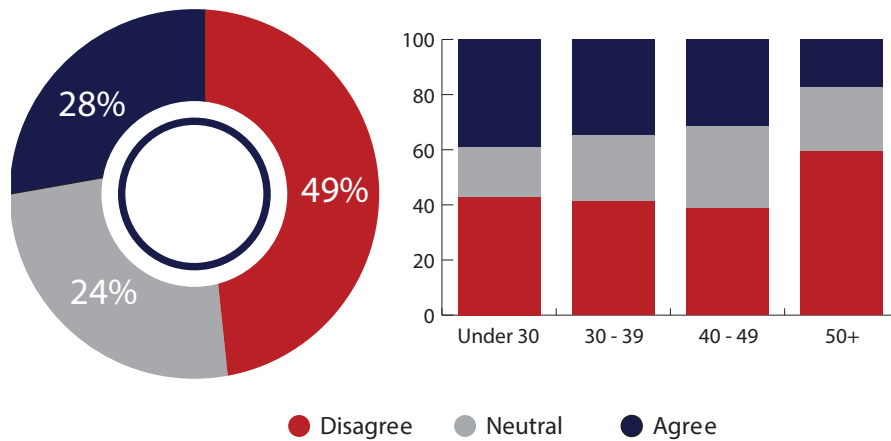


When the statements in the survey become more personal about sharing their own cars, the majority of car-owners seem unwilling to share/rent them to other people (Figure 3.2.2). 66% of car-owning respondents disagree with the statement "I would not mind renting my car to other people". 68% of car-owners cannot see themselves renting their cars to others in the future. However, 20% would not mind renting their car to others, showing that there is a market for peer-to-peer sharing (peer-to-peer car rental). Improving their image within the community does not motivate car owners to rent their cars to others as 64% of them disagree with this statement. The only incentive that can make car-owners consider offering their vehicles on peer-to-peer car rental platforms is a financial one. 38% of the participants agree with the statement "Renting my car to other people could benefit me financially".

Fig. 3.2.2: Car-owners' attitudes towards renting their vehicles to others
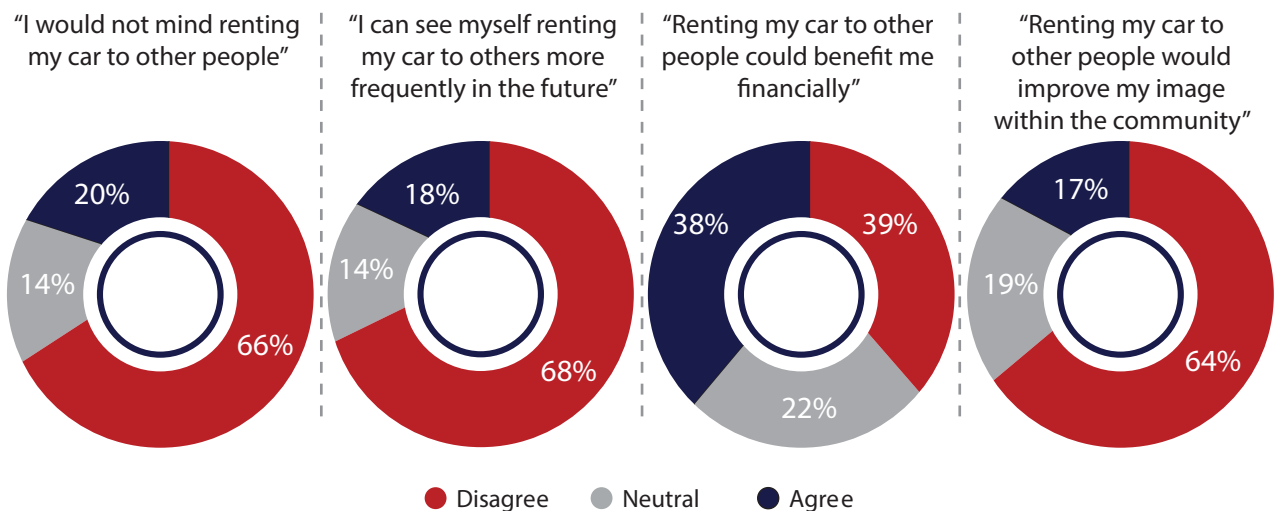
By analysing the aforementioned statements based on the age groups, there are no significant differences (Figure 3.2.3). The age group that seems most willing to rent their cars to other people are 30 to 39 year olds, with 28% of them agreeing with this statement. In addition, 29% of them agree that they can see themselves renting their cars more frequent in the future, while in contrast, only 8% of those over 50 agree with this statement. The financial benefits of renting their cars to other people seem to be more appealing to the age groups up to 49 years old; 49% of the youngest age group, 46% of the 30 to 39 and 46% of the 40 to 49 age groups agree that renting their car could benefit them financially.

Fig. 3.2.3: Car-owners' attitudes towards renting their vehicles to others by age groups
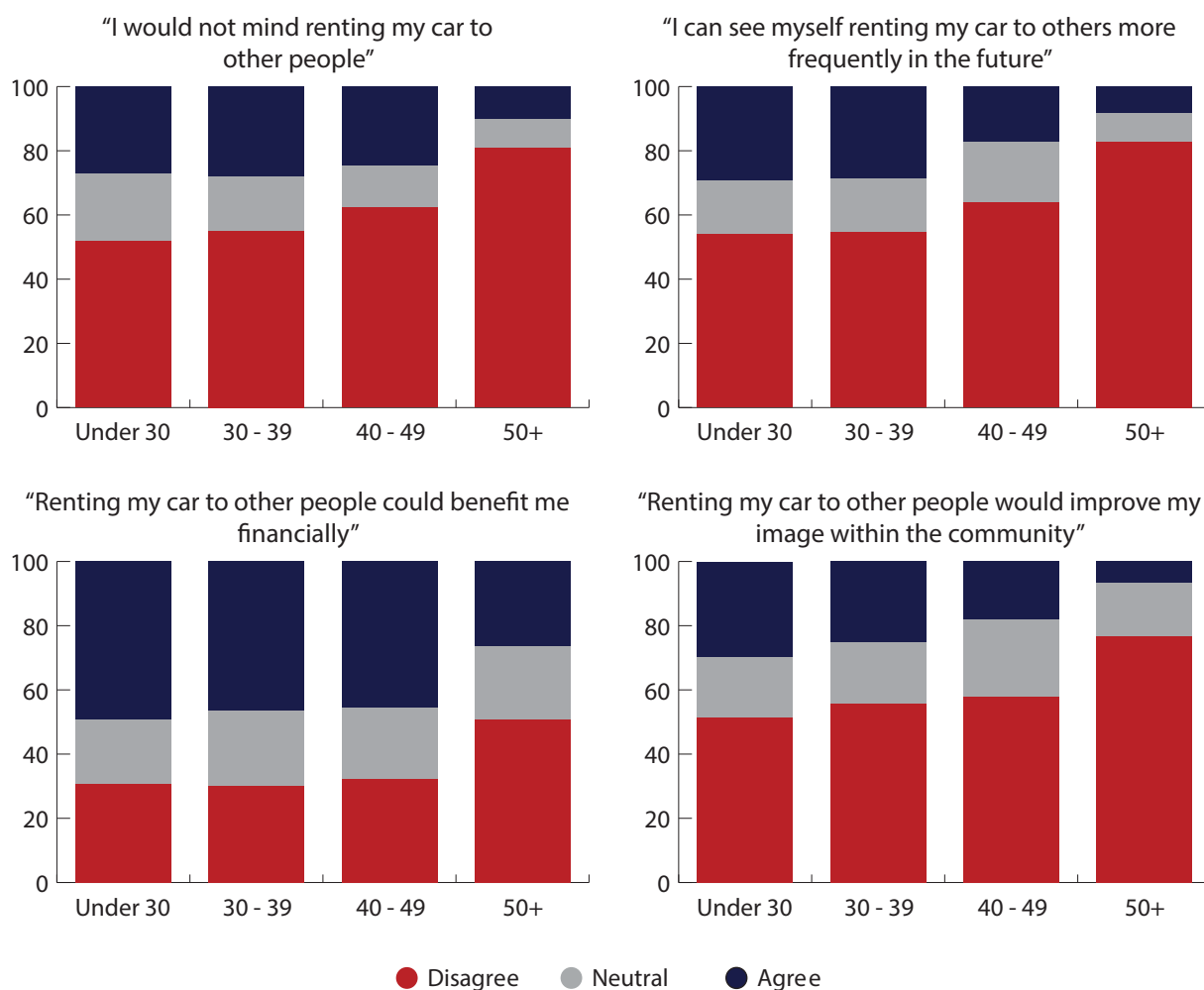


### 3.3 Non-car-owners attitudes towards shared mobility

Below the attitudes of non-car-owning participants towards shared mobility are presented (Figure 3.3.1). 25% of non-car-owners stated that if they had a car, they would be willing to rent it to other people, while 56% disagreed with this statement. Those who would be more willing to share their mobility resources are participants between 30-39 years old.

Although only 25% of participants agreed that if they had a car they would be happy to rent it to other people, 45% of them stated that they would be happy to rent someone else's car if they needed one. The majority of those who agree with this belong to the 30-39 year old group (62%), followed by the youngest age group (45%) and the 40 to 49 age group (39%).

Regarding car sharing/car clubs, 38% of non-car-owning respondents believe that sharing a car instead of owning their own is a good option for them. The groups that mostly agree with this statement are Millennials (up to 39 years old) and those who live in Central London.

Finally, 39% of non-car-owners stated that they would likely participate in a car sharing scheme in the future. Millennials are most willing to participate in car sharing, while a much lower percentage of people over 40 would be willing to do so.

Fig. 3.3.1: Car-owners' attitudes towards renting their vehicles to others

"If I had a car I would happily rent it to other people"
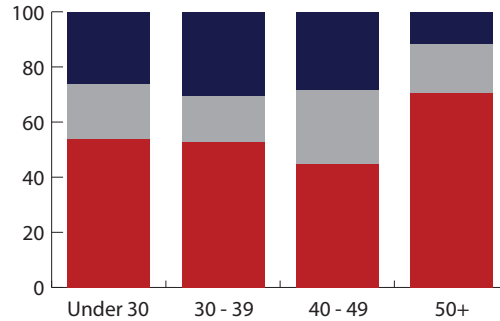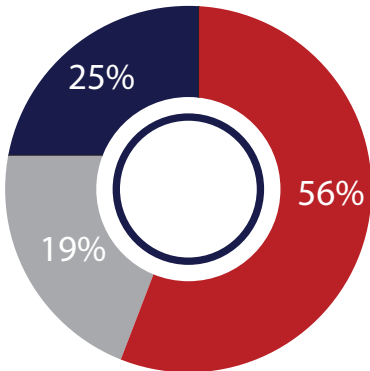


"I would happily rent someone's car if I needed a car"
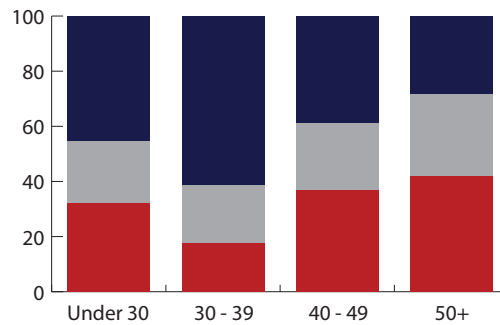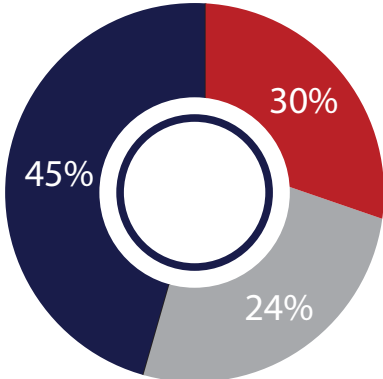


"Sharing a car instead of owning my own is a good option for me"
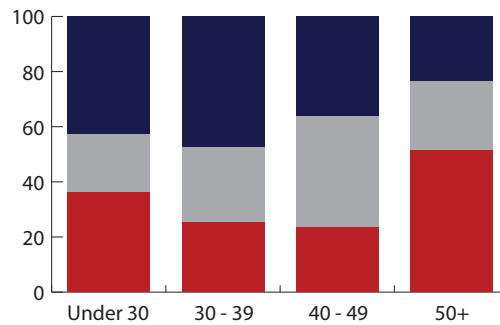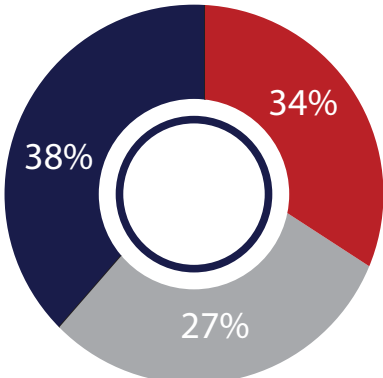


"I will likely participate in car sharing in the future"
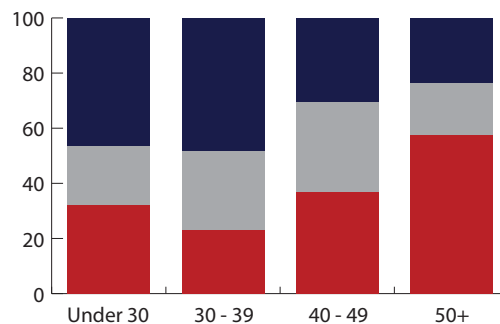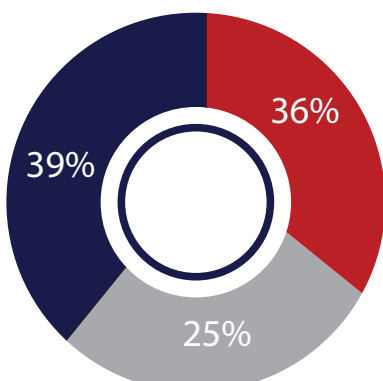


● Disagree　　● Neutral　　● Agree

## Highlights

- Survey results indicate that both car-owners and non-car-owners seem to be in favour of car sharing schemes and they find this concept a good alternative to owning a car.

- Respondents prefer car sharing (car clubs) over peer-to-peer car rental.

  › Only 20% of car-owners are willing to rent their cars to others via a peer-to-peer car rental platform. However, it seems that they change their mind when they anticipate that they can have financial benefits from this.

  › Younger car-owners (up to 39 years old) are more willing to share their cars via peer-to-peer car rental platforms.

- 45% of non-car owners would be happy to rent someone else's car. However, if they had a car, only 25% of them would be willing to rent out their car to someone else. It is easier for consumers to rent/use others' resources, instead of offering/sharing their own mobility resources.

- 39% of non-car-owners see themselves participating in a car sharing (car club) scheme in the future.

- Millenials (up to 39 years of age) are most open to participating in car sharing. The percentages of those who would likely participate in car sharing in the future drop significantly for the age groups over 40 years old.

  In general, the idea of car-ownership has been around for almost a century now, and car manufacturers have invested incredible amounts of money to build the "dream" and the status of owning a car. Car sharing schemes have only been around for almost a decade, yet Londoners seem to have accepted this new concepts quite quickly and a significant percentage of them are willing to use them in the future, instead of purchasing their own cars.

# 4. Attitudes towards MaaS and car-ownership in the MaaS era

MaaS could provide a significant change to the way mobility is currently supplied. However, as the concept is not yet well known within the wider community, and a universal definition is not yet established, it is still questionable how it would be received. As such, it is important to understand peoples' attitudes, perceptions and possible concerns towards it. This section looks at individuals' attitudes towards various characteristics of MaaS (4.1) as well as their attitude towards car ownership if MaaS were available in the form defined in the introduction of this report (section 1.3).

## 4.1 Attitudes towards MaaS

This section focuses on attitudes towards MaaS and towards trying new modes if MaaS were available. To start, elements that could help the diffusion of MaaS (especially at early stages) are examined. As with all bundled services (e.g. restaurant menus, mobile phone subscriptions), pricing the bundle of products below the sum of the same amount of products bought individually is a good strategy to get more people interested. This can be presented to users as discounts or as MaaS special offers, for example getting some free car sharing hours by signing up to the service.

43% of respondents stated that they agree with the statement that "I would be willing to subscribe to MaaS if it gave me discounts", while 38% disagreed (Figure 4.1.1). When looking at it more closely, over 50% of under 30 year olds agree with this statement. This supports the argument above that this age group is the most price sensitive. This finding could help the diffusion of MaaS in the younger age groups. The group with the highest fraction (50%) of respondents disagreeing to this statement is the over 50 age group. This can indicate two things: either they are not price sensitive and would be willing to subscribe to MaaS even without discounts; or even discounts wouldn't be enough to motivate them to subscribe.

36% of the respondents indicated that they agree with the statement "MaaS special offers would motivate me to subscribe to MaaS", while 41% disagree with it (Figure 4.1.1). When breaking it down by age group, under 30 year olds have the highest percentage who agree with being motivated by special offers (51%). This follows the same logic as above, as this group is still early on in their careers (or are still students) and are more price sensitive, thus could be persuaded easily by the potential better value for their money. The other age categories have a similar split between agree-neutral-disagree.

## "MaaS special offers would motivate me to subscribe to MaaS"



- 36% of respondents agree that special offers would motivate them to use MaaS

- The age group with the largest fraction of people motivated by special offers are people under 30

## "I would be willing to subscribe to MaaS if it gave me discounts"



- 43% of respondents would be willing to subscribe to MaaS if it gave them discounts.

- The highest fraction of people who would be motivated by discounts is the under 30 group with 57%

While knowing what could motivate people to subscribe to MaaS is important, it is equally valuable to know which factors discourage them from using the service. 52% of respondents stated that they would "worry about running out of their subscribed amounts of travel", while 26% stated that they would not (Figure 4.1.2). This shows one of the key pain points of subscription services, that people are uneasy about their situation if they were to run out of their pre-paid amounts of the service. In order to mitigate this, MaaS providers should make it clear what happens in such cases. Do they go over to pay as you go? And if yes, at what costs? Breaking down this statement by age, the group where the highest percentage of people are worried about running out of their subscription, is the under 29 age group. 60% of this group agreed with the statement, while only 17% disagreed. The most confident group in MaaS is the over 50 group, who may have more stable and consistent travel plans.

Another potential discouraging factor is that respondents "would feel trapped by subscribing to MaaS". 49% of the respondents agree with this statement, while 25% disagree (Figure 4.1.2). This shows that there is a split in how the population feels about being trapped with MaaS. When breaking it down by age group, similarly to before, over 40s agree most with the statement (51%). This shows the sensitivity and uneasiness of these age groups to multiple characteristics of subscription services. Millennials seem to be less nervous about their commitment to MaaS plans.

**"I would worry about running out of my subscribed amounts of travel"**



- 52% of respondents stated that they would worry about running out of their subscribed amounts of travel
- The aunder 39 age group is most concerned about running out of subscribed amounts of travel, while the over 50 group is least concerned

**"I would feel trapped by subscribing to MaaS"**



- 49% of people would feel trapped by subscribing to MaaS as they correlate this with mobile phone contracts
- The 40-49 and over 50 age groups are most concerned about feeling trapped by MaaS, while under 30s are least concerned

The survey results indicate that MaaS plans could be used as a travel demand management tool and could help motivate people to use more shared and sustainable modes. 40% of the respondents agreed, while 39% disagreed to the statement "I would be willing to try new transport modes they previously didn't use if my MaaS plan included them" (Figure 4.1.3). The fact that some would be willing to use new services is encouraging for MaaS and its potential to induce shift to new services. Almost 50% of those under 40 would be willing to try new modes, while those over 50 are least likely to change their behaviour.

An innovative idea to motivate people to use more active modes is to give them something back for every mile they conduct with these modes. 31% of respondents agreed that they "would cycle more if they were given discounts on MaaS products for every mile" (Figure 4.1.3).  Younger respondents were most likely to agree with this statement, with 48% of those under 30 agreeing, 36% of those between 30-39, 32% of those between 40-49 and just 19% of those in the over 50 age group.

**"I would be willing to try new transport modes I previously didn't use if my MaaS plan included them"**



- 40% of respondents agree that they would be willing to try new transport modes they previously did not use if their MaaS plan included them.

- Millennials are most likely to try new transport modes as a result of using MaaS.

**"I would cycle more if I was given discounts on MaaS products for every mile"**



- 31% of respondents agree that they would cycle more if given discounts on MaaS products for every mile they cycled.

- The highest percentage of respondents who agree to this statement are in the 5under 30 age category, while the over 50 age group is least likely to cycle more.

## 4.2 Attitudes towards car ownership with MaaS

One largely uncertain question is what will happen to car ownership if MaaS were introduced. A hope of MaaS advocates is that it will eradicate dependence on private vehicles in the mid-long term. This section looks at current car owners and non-car owners' attitudes towards cars and car purchasing if MaaS were available.

Below, car owners' attitudes towards statements related to their vehicles if MaaS were available are depicted (Figure 4.2.1). Even though 47% disagreed, 33% of respondents who own private vehicles agreed that "MaaS would help me depend less on my car". This shows that MaaS has the potential to assist in the shift away from private vehicle dependence. Furthermore, 30% of car owning respondents agreed that "MaaS would resolve all the hassle related to owning a private vehicle from my daily life".

An innovative concept to help decrease private vehicle ownership is to give car owners unlimited access to car sharing in exchange for giving up their cars. 26% of respondents agreed that "I would be willing to sell my car if I had unlimited access to car sharing for the next couple of years". This also shows that these people are not emotionally connected to their own vehicles, they just need access to a vehicle. 30% of car owning respondents agreed to the statement "I would be willing to rent out my car to other MaaS users for a fee". This indicates that there is demand (albeit low for the moment) for peer to peer car sharing within the MaaS framework.

**"MaaS would help me depend less on my car"**

33%
47%
20%

**"MaaS would remove all the hassle related to owning a private vehicle from my daily life"**

30%
51%
19%

**"I would be willing to sell my car if I had unlimited access to car sharing for the next couple of years"**

26%
61%
13%

**"I would be willing to rent my car to other MaaS users for a fee"**

30%
51%
19%

● Disagree  ● Neutral  ● Agree
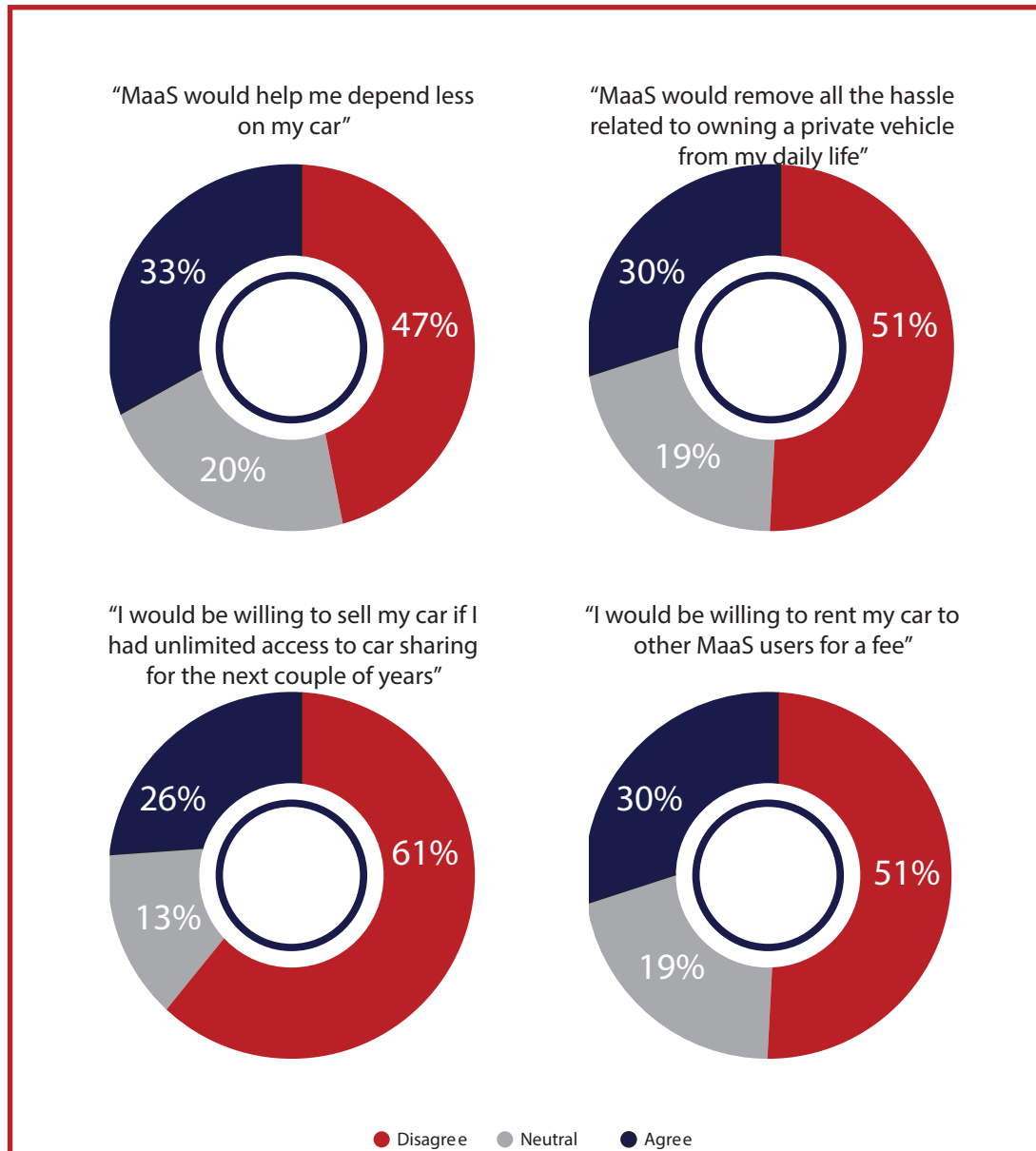
- 33% of respondents who own a private vehicle agree that MaaS would help them depend less on their cars

- 30% of respondents who own a car agree that MaaS would remove the hassle related to owning a car

- 26% of car owning respondents would be willing to sell their car if they had unlimited access to car sharing for the next couple of years

- 30% would be willing to rent their cars to other MaaS users

Looking solely at non-car-owners, 36% of respondents agreed that "If MaaS were available I would delay buying my own car" while 36% disagreed (Figure 4.2.2). The fraction of those who agree with this statement is lower among those who live in central London compared to other zones. When looking at it by age group, the groups with the highest fraction of individuals agreeing with this statement are the under 30 and 30-39 brackets, both with over 38% and 50% of respondents respectively agreeing. This is very important to understand, as MaaS has potential in exposing and familiarising non-car-owners with shared services, so that later they consider delaying or not purchasing vehicles at all.

Fig. 4.2.2: MaaS and car-ownership (1)

"If MaaS were available I would delay buying my own car"

36%   36%

28%
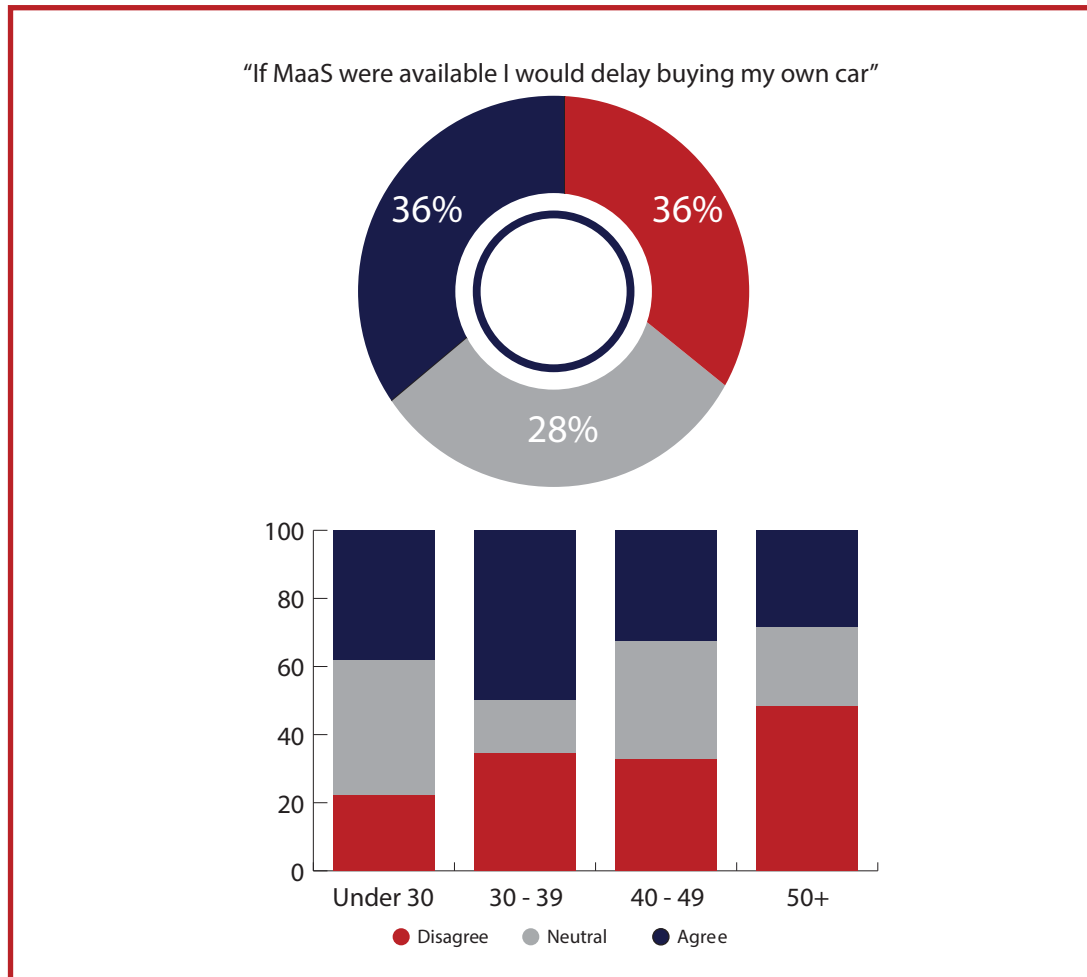
- 36% of current non-car owning respondents agree that if MaaS were available, they would delay buying their own car

- Millennials agree most with this statement, with 50% of those between 30-39 saying that they would delay buying a car as a result of MaaS

Continuing to look at non-car-owners, 40% of respondents agreed and 26% disagreed with the statement "If MaaS were available I would not need to buy a car at all" (Figure 4.2.3). These results are very much in line with those for the previous statement, with only minor differences. This, alongside the numbers above for delaying car purchase, are very positive and show the potential impact MaaS can have on future car purchasing behaviour. One of the important elements of MaaS is the effect it can have in the mid to long term, as it could shift user behaviour with regards to long-term decisions. Looking at it by age group, the results resonate with those for the previous statement in that within the younger age groups, more people agree that car ownership is less important. This is particularly important when the results from section 2 are considered, where 59% of those under 30 stated that they would definitely buy a car in the future (fig. 2.3.3), demonstrating that MaaS could have a positive impact on car ownership in London for younger generations.

Fig. 4.2.3: MaaS and car-ownership (2)
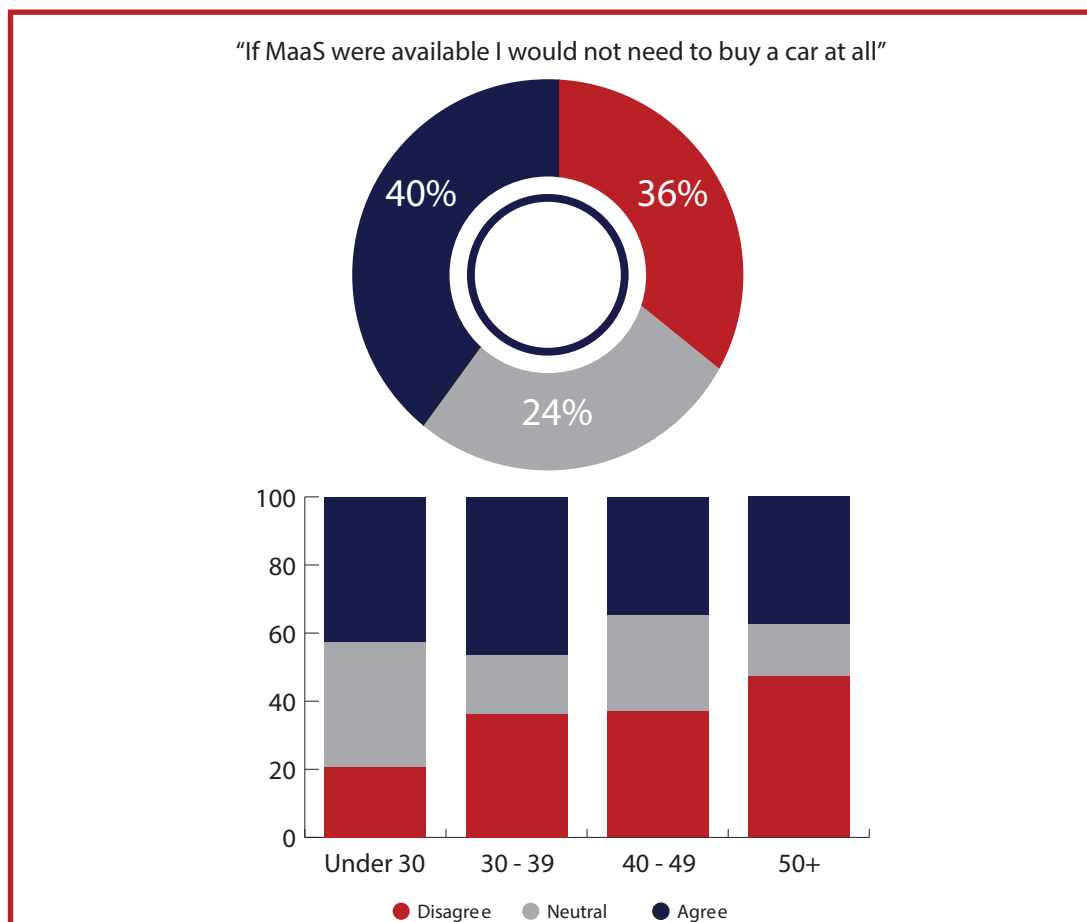


- 40% of respondents who currently do not own a car agree that if MaaS were available they would not need to buy a car at all

- 47% of respondents between 30-39 years old would not buy a car were MaaS available, as would 43% of those under 30

## Highlights

- 43% of all respondents would be motivated to subscribe if MaaS gave them discounts. This percentage increases to 50% for the most price sensitive under 30 year olds.

- 52% of respondents stated that they would worry about running out of their subscribed amount, while 49% would feel trapped by subscribing to MaaS. The over 40 age groups have the highest fraction of people who feel this way about both these statements indicating that they feel uneasy about multiple characteristics of subscription services.

- MaaS could be used to introduce people to public and shared transport modes, as 40% of the respondents agreed that they would try modes they previously didn't use if their MaaS plan included them.

- Giving individuals discounts for using active modes through MaaS schemes can be a possible way to encourage usage of these modes. 31% of respondents agreed that they would cycle more if they were given discounts on MaaS products for every mile.

- MaaS has the potential to impact current car owners' car usage and ownership behaviour. 33% of car owners agree that MaaS would help them depend on their cars less, while a fifth of them would even be willing to sell their cars for unlimited access to car sharing for the next couple of years.

- More than a third of respondents who currently don't own a car would consider delaying purchasing a vehicle or not buying one at all if MaaS were available.


Overall, even though there is still much to learn about MaaS, there are some promising insights to take away from this section. Discounts could motivate individuals, especially young people, to join MaaS and even use active modes more. MaaS plans can help balance the modal split, by introducing people to modes they previously didn't use. Finally, MaaS could support the shift away from the private vehicle ownership by helping car owners depend less on their private vehicles and delay or diminish the need for non-car-owners to purchase these.

"This chapter has intentionally been removed.
For more information, please contact the MaaSLab"

# 6. MaaS evaluation and scenarios for the autonomous vehicle era

This section provides insights into the overall impact MaaS could have on the city's transportation system both from the transport operators' and travellers' perspective. First survey results on the potential effect MaaS could have on mode switching are presented. This is followed by a thought experiment on the impact MaaS could have on public transport, the economy, health, the environment and users.

## 6.1 MaaS impact on mode switching

Understanding what impact MaaS could have on mode switching is crucial for transport operators to prepare for potential under or overprovision of certain modes. Survey participants were segmented into regular public transport users and regular car users, and questions regarding potential mode switching from these modes were specifically targeted at each segment. They were asked to indicate what their most likely substitute would be if MaaS were available, for public transport and car respectively.

Out of those respondents who are currently regular public transport users, 28% stated that if MaaS were available, they would increase their use of public transport, demonstrating the potential role MaaS could play towards a more effective integration of transport modes (Figure 6.1.1). 23% would not change their use of public transport as a result of MaaS.  22% would most likely substitute part of their public transport usage with taxi. 14% stated that MaaS would make them substitute part of their public transport use with bike sharing, which shows that some public transport use could potentially be replaced with active modes. This, together with a further 12% shifting to car sharing, indicates that MaaS could foster increased usage of shared modes.

Fig. 6.1.1: Most likely substitute for public transport trips if MaaS were available



"Most likely substitute for public transport trips with MaaS"

| | |
|---|---|
| I would use more public transport | 28% |
| No Impact | 23% |
| I would substitute some public transport trips with taxis | 22% |
| I would substitute some public transport trips with bike share | 14% |
| I would substitute some public transport trips with car sharing | 12% |
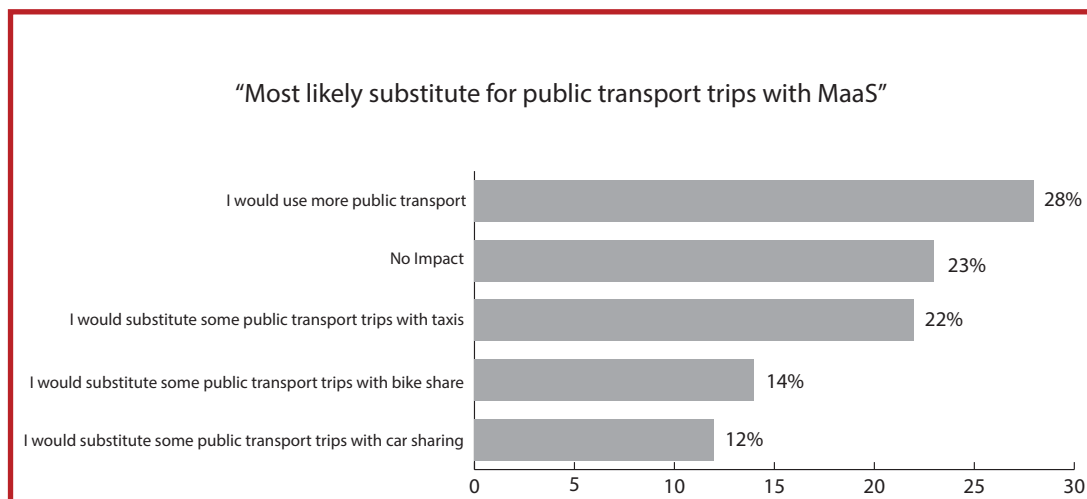
- 28% of respondents would use more public transport when using a MaaS platform, while 23% stated MaaS would have no effect on their public transport useage

- 22% would substitute public transport for taxi, while 14% would use bike share and 12% would use car sharing

Turning to regular car users, almost a fifth of respondents stated that they would most likely substitute part of their car trips with bus (figure 6.1.2). 17% would transition some trips to bike, while a further 17% would walk more instead of taking the car. 17% of the respondents stated that they would most likely substitute part of their car trips with tube/rail. 13% would not change their car use if MaaS were available. 11% would transition to taxi, while 7% would substitute their private car trips with car sharing if MaaS were available, which again points at the subpopulation who aren't attached to their own vehicles, just need access to one.

Fig. 6.1.2: Most likely substitute for car trips if MaaS were available



"Most likely substitute for car trips with MaaS"

- 18% of individuals stated that bus would be the most likely substitute for car trips if MaaS was available
- 17% would increase their bike use and another 17% would walk more as their primary mode
- 17% would use more tube, DLR or rail
- 13% would not substitute their car use as a result of MaaS
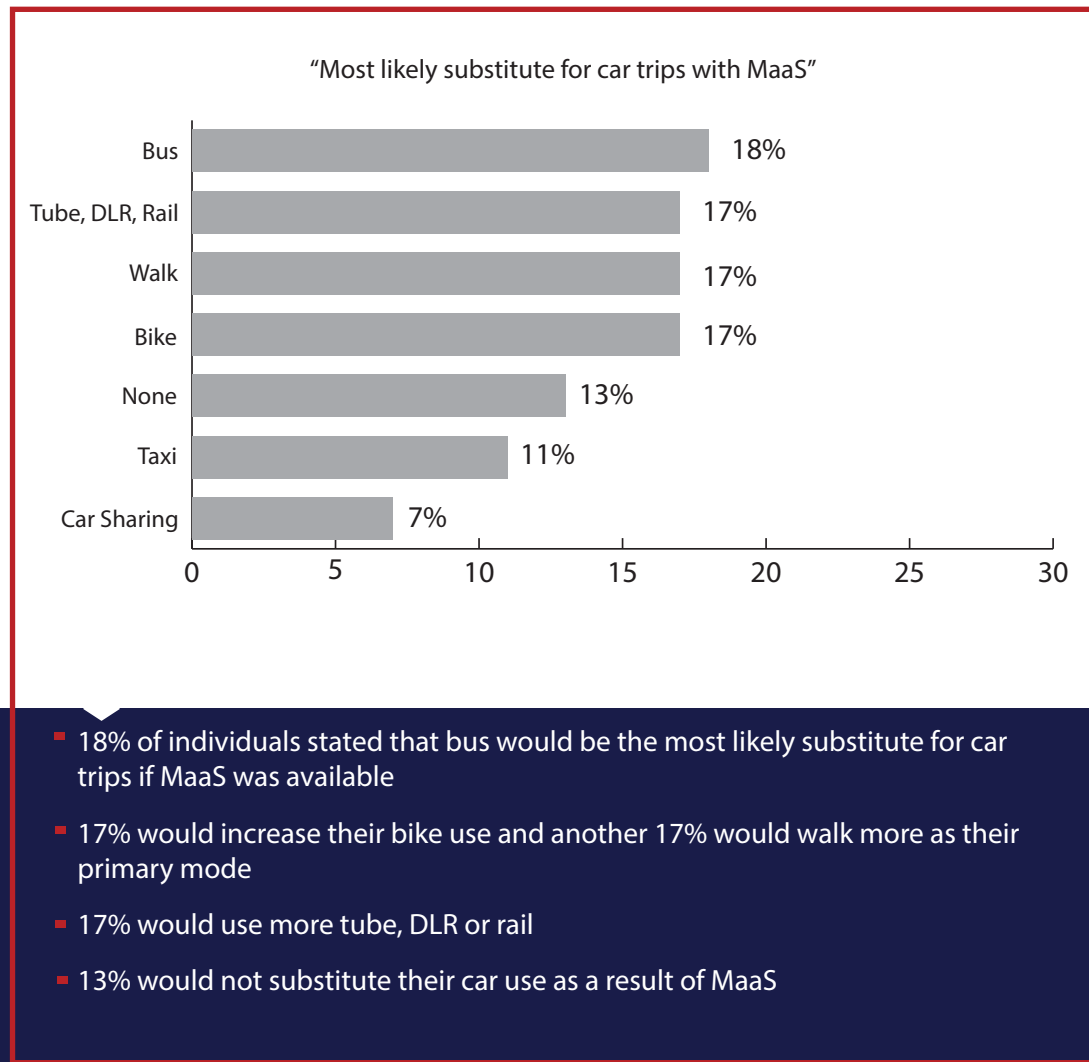
## 6.2 Wider impact assessment of MaaS for London

As can be seen above, MaaS, if designed, structured and priced appropriately, is likely to have a positive impact on many elements of transport in cities, reducing reliance on private vehicles, increasing use of public transport and incentivising intermodality as well as active transport modes. It can be expected that these changes will bring with it a positive outcome to issues such as congestion, parking, air quality, ticket sales and operators' revenue. However, further research is needed on these topics in order to gain a comprehensive understanding of these impacts with quantifiable evidence. Testing MaaS products through pilot case studies would help to provide the evidence needed to demonstrate the wider impacts. It is worth highlighting that the specific configuration of MaaS would play a crucial role in determining the impact it would have on the city.

Additionally, MaaS could have further impacts on a variety of sectors beyond transport, such as the economy, data, the environment and health as well as society. The assessment below (presented in tables 2 to 6) is a thought experiment[25] rooted in the analyses presented above rather than detailed network, operational or commercial modelling. For each topic, the impacts and their scale are assessed. It provides some indications as to the ways that an appropriately structured MaaS system could impact the city.

Table 2: Impact assessment of MaaS on Public Transport

| Topic | Expected Impact | Scale of Impact |
|---|---|---|
| Passenger demand | - The demand for public transport services is likely to rise as a great proportion of car users would increase their usage of public transport (Fig. 6.1.2).<br><br>- The extent to which the demand could rise depends largely on the chosen MaaS plans (Fig. 5.2) and the degree of switching away from public transport (22% of the regular public transport users stated that they would substitute part of the usage with taxi).<br><br>- Overall, it is noticed that the percentage of the participants who stated that they would increase the use of public transport is higher than those who stated that they would decrease their public transport use. As such, it is expected an overall increase in public transport demand. | Expected Minor Positive |
| Capacity optimisation | - MaaS could improve the network efficiency and optimise capacity (supply) and demand.<br><br>- Especially in peak hours, the excessive demand can be redirected to under-utilised routes or other transport modes. | Expected Positive |
| Flow at stations | - The single ticketing and payment feature of MaaS is an option that TfL already offers for all public modes apart from bike sharing. As such, the contribution of MaaS to the flows at ticketing machines at tube stations would probably be negligible.<br><br>- TfL and several journey planners already offer information (both static and real time), which contributes to a reduced volume of enquiries at stations. MaaS may slightly contribute to a further reduction in enquires at stations. | Neutral (depends on MaaS design) |
| Intermodal connectivity | - Internally, tube, rail, bus and bike sharing services will be more tightly connected from passengers' point of view as they can access the information of these services all in one place.<br><br>- Externally, public transport will be connected with the other transport modes available in the city contributing to the achievement of seamless intermodal door-to-door mobility.<br><br>- The ticketing and payment integration of the public transport modes with the other modes that will agree to offer their services via the MaaS operators will contribute to a seamless use of different transport modes and will probably increase the number of intermodal trips. | Expected Positive |

[25] A thought experiment is a device with which one performs an intentional, structured process of intellectual deliberation in order to speculate, within a specifiable problem domain, about potential consequents (or antecedents) for a designated antecedent (or consequent) (Yeates, 2004)..

| | | |
|---|---|---|
| Revenue | - The potential increase in demand will generate additional revenue to TfL, which could be reinvested.<br><br>- The analysis results in Section 5 also show that Londoners widely prefer MaaS plans that definitely include public transport (both tube and bus).<br><br>- The integration of the public and the other transport modes would reinforce the demand for both increasing the revenue and market shares for both (this increase in the market share of the transport operators is expected to come from the reduction in the usage of private vehicles).<br><br>- MaaS, if designed, structured and priced appropriately, could potentially remove a certain number of private vehicles off London roads (given the current road pricing schemes remain unchanged), as only 25% of the car-using participants stated that they would not switch modes at all when MaaS is available. Assuming that there would be no change in the fleet of the transport operators, this switch away from private vehicle use could alleviate congestion. | Expected Minor Positive |
| Number of private vehicles on the road | - The analysis of the MaaS plans preferences indicated that participants are in favour of choosing plans where the taxi was offered also as a shared option (taxi-pool). This finding indicates that MaaS could also contribute to increasing the vehicle occupancy of taxis (as such there would be no need to increase the taxi/ridehailing fleet).<br><br>- The analysis of the MaaS plans preferences indicated that participants are in favour of choosing plans where the taxi was offered also as a shared option (taxi-pool). This finding indicates that MaaS could also contribute to increasing the vehicle occupancy of taxis (as such there would be no need to increase the taxi/ridehailing fleet). | Expected Minor Positive |
| Travel data for planning | Given products that MaaS operators could offer, it is expected that they could provide high quality travel data (and especially data for intermodal trips) back to the transport authority that could be used for transport planning purposes. After following all the data protection standards, TfL could have the option to negotiate and secure the provision of anonymised (and probably aggregated) travel data from the MaaS operators. | Expected Positive |

**Table 3:** Impact assessment of MaaS on London's economy

| Topic | Expected Impact | Scale of Impact |
|---|---|---|
| New business opportunities<br><br>(for this assessment we anticipate that the MaaS market is open) | - In case the MaaS operators are private enterprises then they have to pay taxes, which will generate income for the government.<br><br>- MaaS could also provide new business opportunities to data provider companies as the requirements for high quality, real time data processing will be high.<br><br>- New business opportunities could also arise for journey planer companies, ticketing and payment companies, as well as IT companies. Instead of reinventing the wheel, MaaS operators can host on their platforms existing journey planners, payment and ticketing solutions.<br><br>- The operation of MaaS has high requirement on ICT infrastructures such as high-speed internet (4G) and widespread geographical internet coverage. As such, MaaS could expand the market for ICT companies as well.<br><br>- MaaS could also unravel business opportunities for insurance companies providing them the option to expand their portfolio and increase their revenue. Insurance providers may be called upon for example when a transport mode proposed by MaaS is unable to respond to the request.<br><br>- Further opportunities could be generated for media, advertising, entertainment and food/coffee companies (etc.), as the MaaS operator could include their services in the MaaS plans to advance customers' travel experience. | Expected Positive |
| Revenue to transport operators | - Transport operators via the MaaS operator(s) have the opportunity to access a wider market and increase their market share.<br><br>- Transport operators also have the opportunity to grow their revenue from previously 'unreachable' customer segments. The MaaS system can optimise demand and supply by knowing in real time the demand and the capacity of transport operators. This would be valuable in peak hours when some of the transport operators run on full capacity and MaaS could redirect their demand to other transport operators.<br><br>- There will however be short-term costs for some transport operators that do not have APIs for routing, ticketing and payment, as they would need to invest for designing these APIs. MaaS may require real time positioning of the transport operators' vehicles meaning that they should invest on installing sensors on their fleet. In some transport operators may need to install systems that accept smartphone reading in order the MaaS user to access the modes.<br><br>- Additionally, the MaaS system creates the potential for direct competition between engaged operators. The outcome may be reflected on a decrease in prices and in turn the revenue to operators. | Expected Positive |
| Corporate travel | MaaS customers can be individual travellers (Business to Customer model) or companies (Business to Business model). In the latter case, the service could offer customised packages and match companies' special requirements. Companies could take this opportunity to cut down their employees' travel costs and avoid the fixed costs of purchasing vehicles. In addition, the MaaS operator could not only save money, but also time to the companies from processing travel claims and expenses. | Expected Positive |
| Time Saving | Based on a study of Inrix, London is the city with the highest number of congested spots among 21 cities. They also indicate that London pays the highest price with time wasted in congestion potentially costing drivers in the capital £42 billion over the next decade. MaaS, if structured and priced appropriately, by its potential impact on congestion alleviation could contribute to a decrease to this amount. | Expected Minor Positive |

Table 4: Impact of MaaS on data availability for planning

| Topic | Expected Impact | Scale of Impact |
|-------|-----------------|-----------------|
| Data quality | - A well-operated MaaS system can gather abundant and highly-reliable travel behaviour data as every piece of the travel information (origin-destination, interchanging points, trip duration and cost etc.) will be captured and stored automatically when using the MaaS services.<br><br>- The authority can make use of the available data to design more effective policies for many purposes.<br><br>- Customers' data protection protocols (anonymisation and aggregation) should be applied when data is transferred to the collaborators/suppliers of the MaaS operator(s). | Expected Positive |

Table 5: Impact assessment of MaaS on the environment

| Topic | Expected Impact | Scale of Impact |
|-------|-----------------|-----------------|
| Air quality | - MaaS has the potential to decrease private vehicle use due to behavioural changes of car owners (only 25% of car users stated they would not consider alternative options if MaaS were available) and non-car-owners (42% stated they would not buy a car in the future). These shifts away from private vehicles could alleviate congestion which would cause meaningful improvements to air quality.<br><br>- However, the decrease in congestion and associated air quality improvements depend on what modes car users are shifting to. 35% of car users stated that they would shift to public transport and 17% to walk which would have positive effects. 7% would shift to car sharing, which depends on the fuel-type of the shared fleet; if the shared vehicles are electric then the contribution to the air quality would be considerable. 11% would use ride-hailing (P2P taxi); once again this change's impact on the environment depends on the fuel type of these vehicles (ride-hailing cars).<br><br>- It is estimated that the demand for car sharing will increase via MaaS. Car sharing services utilize vehicles more efficiently than individual households, while the time utilization of shared vehicles is more than eight times that of private vehicles. As a result shared vehicles are replaced faster than private vehicles. This means that the technology and fuel efficiency of the shared fleet could closely follow the emission standards imposed by the Ultra Low Emission Zone (ULEZ) scheme and the EU.<br><br>- Nevertheless, MaaS, in conjunction with the incoming ULEZ scheme, could make sure the 'polluters' pay, not the others. ULEZ will charge all car users; however, by introducing MaaS, those who are willing to contribute to air pollution reduction are offered an equally convenient alternative to their cars and can therefore avoid the charge. | Expected Minor Positive |
| Noise | - Fewer cars and more active modes are expected to be on streets meaning that the noise level could go down.<br><br>- There could however be additional noise arisen from the interchanges across transport services. | Expected Minor Positive |

| Landscape and urban realm | - As private car ownership is expected to drop, some car parks could become redundant and could be rebuilt to serve other purposes. Much of the on-street parking will also be freed allowing for more pedestrian and retail spaces and an overall better living environment for residents.<br><br>- However, the volume of street parking for shared-vehicles is likely to grow given the increasing demand for car sharing, an important substitute to private car (Fig. 6.1.2). In this case, the parking space for private vehicles will just be used as parking space for shared vehicles. | Neutral (Depends on MaaS design) |
|---|---|---|

Table 6: Impact assessment of MaaS on health

| Topic | Expected Impact | Scale of Impact |
|---|---|---|
| Air pollution | Given the 'Minor positive' effect on air pollution reduction, it is expected that, provided MaaS is appropriately designed, there could be a minor positive impact on health. | Expected Minor Positive |
| Noise | Similar to the above. | Expected Minor Positive |
| Physical activity | The level of physical activity is expected to be higher than the current status. It is shown that some car users are willing to use bike sharing and walk more when MaaS is available (Fig. 5.3, Fig. 6.1.2). Additionally, the more frequent interchanges across modes will inevitably incur extra walking to travellers. Overall, MaaS could contribute to the demand of active transport modes. | Expected Minor Positive |

Table 7: Impact assessment of MaaS on Londoners

| Topic | Expected Impact | Scale of Impact |
|---|---|---|
| Travel cost saving | Via MaaS, car owners could have a good alternative to owning a car, as 23% of the car-owner respondents stated that MaaS would help them depend less on their cars. A proportion of them may also opt to sell their cars in the future and use MaaS instead. MaaS could relieve households of the costs associated to car-ownership, which in our survey have been estimated to £2,802 per annum (see Table 1).<br><br>- MaaS users may be able to benefit from an overall cost reduction and better value for money by purchasing bundled mobility packages (MaaS plans).<br><br>- Depending on the design of each MaaS service, cheapest modes and routes could be proposed to users (especially to the pay-as-you-go users). | Expected Positive |
| Travel time saving | Significant reduction in journey time is highly expected. MaaS users can save time with the single ticketing and payment service to speed up interchanges, and avoid congested roads and public transport networks by having real-time, intermodal information. | Expected Minor Positive |
| Travel experience improvement | - The hassle-free interchanges, the better control over disruptions and the personalised mobility packages would increase the convenience and comfort levels and hence make travellers more satisfied with their journeys.<br><br>- The personalised real time travel information that MaaS apps can offer would also lead to better user experience. | Expected Positive |

| Equalities | | |
|---|---|---|
| Age (younger <30) | The younger generation is very likely to benefit from MaaS. The percentages are high in saying they would delay buying a car (38%) or would not buy a car at all (43%) if they can use MaaS (see Fig. 4.2.2, Fig. 4.2.3). | Expected Positive |
| Age (older 50+) | - MaaS is found to affect the eldest group the least as the corresponding percentages to "would delay buying a car" (28%) or "would not buy a car at all" (37%) are the lowest among all age groups.<br><br>- However, not everyone in the age group will have access to or be comfortable using smartphones to aid in travel purposes. These people may find it difficult to use MaaS services. This will only be a problem in the mid-term as those growing up in the smartphone era will carry this technological knowledge on to when they become older. | Expected Minor Positive |
| Disabled travellers | The seamless mobility will in general enhance the accessibility of disabled travellers, due to the fact that MaaS can assign special vehicles to this population group. | Expected Minor Positive |

# Highlights

- 28% of the regular public transport users stated that their usage of public transport would increase if if MaaS were available while 23% of them would not change their behaviour. Meanwhile, 22% would most likely substitute part of their public transport usage with taxi.

- 35% of the regular car users stated that their car usage would be changed for public transport, with 18% of trips moving to bus and 17% to tube/rail. Additionally, there would be an increased uptake of active transport modes with MaaS.  7% of users would swap to car sharing instead of private vehicles.

- MaaS is expected to cut down Londoners' travel cost and travel time, improve their travel experience as well as reduce their dependence on private cars.

- Public transport would benefit significantly from joining MaaS in terms of better capacity optimisation and better intermodal connectivity. It is also expected the demand for public transport will rise and so will the revenue to the operator.

- MaaS can open up new business opportunities for the operator of MaaS, data provider companies, and ICT and insurance industries etc.

- MaaS, in conjunction with the Ultra Low Emission Zone (ULEZ) scheme, could make sure the 'polluters' pay, not the others. ULEZ will charge all car users; however, by introducing MaaS, those who are willing to contribute to air pollution reduction are offered an equally convenient alternative to their cars and can therefore avoid the charge. In comparison, those who will still drive while MaaS is available will have no excuse to avoid the charge.

- When the era of autonomous vehicle comes, MaaS systems and automated vehicles will exist in symbiosis. MaaS users will only need one account to access the automated vehicle services supplied by different public transport and shared mobility companies. MaaS will also help utilise the time freed from driving by capturing travellers' preferences on whether they want to arrive at destination in the shortest amount of time or would rather be able to use the time productively. In addition, the real-time information offered by MaaS will be more efficiently processed by automated vehicles.

- MaaS could also aid in achieving a future situation where people prefer public transport and shared mobility services in the automated vehicle era. MaaS actually brings an opportunity to change travel behaviour prior to the mass adoption of automated vehicles. If more people shift away from private cars nowadays via MaaS, it will more likely lead to a boom in public transport and shared mobility sectors when the era comes, rather than a swarm of privately owned automated vehicle.

# 7. Opportunities that lie ahead

## 7.1 MaaS in the connected and automated vehicle era

Understanding Even though MaaS developments will most likely reach maturity well before driverless vehicles are ready for mass adoption, it is worth looking ahead to the automated vehicle era. Public transport looks like a frontrunner. Driverless rail and underground lines have been operating for quite some time, and a few automated bus fleets are already in operation (e.g. Arma bus in Las Vegas and Intellibus in Western Australia). Meanwhile, the shared mobility sector is also expected to change. With a wider application of automated vehicles in the future, car sharing, ridesharing and ride-hailing services could be delivered by driverless vehicles as well.

When the time comes, MaaS systems and automated vehicles will exist in symbiosis. First of all, as in the non-automated case, MaaS users will only need one account to access the automated vehicle services supplied by different public transport and shared mobility companies. With automated vehicles, travel time can be used for other useful activities such as reading, sleeping or working etc. Hence, minimising travel time will not always be the best option and the MaaS system will help utilise this by capturing travellers' preferences on whether they want to arrive at their destination in the shortest amount of time or would rather be able to use it productively. Furthermore, the real-time information offered by MaaS will be more efficiently used. In case of a disruption, instead of informing a vehicle driver and letting the driver be in the hassle of re-routing, an automated vehicle can process the information faster and generate the best decision. At urban level, this could allow for better system optimisation and decongesting the city.

To take one step back, MaaS could also aid in achieving a future situation where people prefer public transport and shared mobility services in the automated vehicle era. An opposite situation that could possibly occur is the flourishing of privately owned automated vehicles given that all the current barriers to driving such as parking, driving license and opportunity cost of the time spent driving will vanish. In fact, the latter situation is more likely to occur if travel behaviour patterns persist as they are now (i.e. private car is still an important travel option). As a result, more severe congestion and air pollution would be expected in urban areas. By having such a risk, it is imperative to make MaaS function as early as possible whilst ensuring it is carefully-designed and appropriately priced to reach its full potential for the benefits of all Londoners. Results in the previous sections have shown that an implementation of an effective MaaS system could reduce people's dependence upon owning and using private cars. Hence, MaaS actually brings an opportunity to change travel behaviour prior to the mass adoption of automated vehicles. The more people shift away from private cars via MaaS today, the more likely it is to lead to a boom in public transport and shared mobility sectors when the driverless era comes, rather than a swarm of privately owned automated vehicle.

## 7.2 Insights for further research

This report provides a number of key findings for the future of car-ownership and MaaS in London. In general, people seem prepared for a shift in the way they travel towards the sharing economy. Respondents to the survey indicate that with a MaaS solution available to them, they would be less likely to buy a car. Moreover, some would choose to replace car journeys with public transport with MaaS giving them more flexibility between modes. MaaS packages including both public transport and ride-hailing proved popular among respondents and would make up a large proportion of the shift away from private vehicles. However, it is clear that many of the benefits of MaaS are contingent on the careful setup of MaaS to include the appropriate modes and pricing models.

As such, further research is needed to gain a more complete understanding of the role MaaS could play in the future of transport in London, as well as its impact on the transport network, congestion, emissions, energy consumption and society more generally. The best way to address the outstanding research gaps would be through the implementation of pilots or demonstrations of MaaS in the city. These would allow the full testing of the service so that empirical results could show the actual impact of MaaS. Additional surveys and the development of comprehensive transport models to test the MaaS concept and the

potential MaaS business models could be used in parallel to strengthen the analysis. The following topics provide an initial list of areas that should be examined:

Business Models:
- MaaS operator(s): what kind of organisation(s) could the MaaS operator be (for example, transport authority, private company, transport operator);
- Market structure: would MaaS perform best with a single large operator or would competition (open market) further increase its value;
- Revenue & pricing: how should MaaS be placed in the context of transport operators and how should prices be determined compared to the status quo.

Transport Models:
- Demand shift: through more advanced models try to understand how new mobility services and intermodal trips would change people's demand for services;
- Network analysis: determine how MaaS could impact road use and availability of modes in different parts of the journey - could some parts of a journey be replaced by different services;
- Supply-Demand optimisation;
- Congestion: through a combination of demand and network analysis a more complete understanding on how MaaS could change congestion and capacity could be reached;
- Climate change: what impact would implementation of MaaS have on emissions and air quality.

Consumer Behaviour:
- Willingness to pay for shared modes and MaaS products;
- Attitudes towards shared mobility and MaaS services;
- Preferences for MaaS products and user segmentation;
- Attitudes to the inclusion of active transport in MaaS platforms.

Data and Technology:
- Availability and specification formats of APIs for planning, booking, ticketing and payment;
- Data sharing barriers to MaaS;
- Importance of openness between parts of the transport system.

Urban/Spatial planning:
- Land-use changes;
- Network expansion.

# APPENDIX A

|  | Total Sample<br>N = 1,570 obs. | London Statistics<br>N = 14,726 obs.<br>(source: LTDS 2014,<br>18+only) |
|---|---|---|
| Gender |  |  |
| Male | 45% | 47% |
| Female | 55% | 53% |
| Age |  |  |
| Up to 29 | 21% | 21% |
| 30 – 39 years old | 25% | 22% |
| 40 – 49 years old | 16% | 18% |
| Over 50 years old | 38% | 39% |
| Marital Status[26] |  |  |
| Single | 32% | Not available |
| Married | 59% | Not available |
| Divorced/Widowed | 9% | Not available |
| Educational level[27] |  |  |
| No formal qualifications | 3% |  |
| Basic (GCSE or equivalent, high school diploma) | 39% | Not available |
| Bachelor's degree | 33% | Not available |
| Masters degree | 17% | Not available |
| Doctoral degree | 8% | Not available |
| Ethnicity |  |  |
| White British | 72% | 52% |
| Irish | 1% | 2% |
| Other White | 11% | 15% |
| Mixed or multiple ethnic groups | 2% | 2% |
| Black or Black British | 3% | 10% |
| Asian or Asian British | 8% | 17% |
| Other ethnic group | 3% | 2% |

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[26] Marital status is not captured by LTDS.

[27] Educational level is not captured by LTDS.

| | Total Sample N = 1,570 obs. | London Statistics N = 14,726 obs. (source: LTDS 2014, 18+only) |
|---|---|---|
| Household Income | | |
| Up to £19,999 (1,2,3,4) | 19% | 20% |
| £20,000-£35,000 (5,6) | 21% | 12% |
| £35,000-£50,000 (7) | 17% | 9% |
| £50,000-£75,000 (8) | 15% | 10% |
| £75,000-£99,000 (9) | 10% | 5% |
| £100,000 or more | 8% | 6% |
| Prefer not to say | 10% | 38% |
| Kids in the Household | | |
| No kids | 74% | 84% |
| Have kids | 26% | 16% |
| Driving license | | |
| Has license | 75% | 67% |
| Does not have license | 25% | 33% |
| Have household vehicle | | |
| Household has vehicle | 66% | 66% |
| Household does not have vehicle | 34% | 34% |